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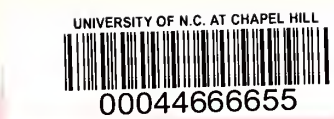

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REPORT ON THE PROPOSED DEVELOPMENT OF THE ROANOKE RIVER BASIN

BY

THE RIVER BASIN COMMITTEE

OF

THE VIRGINIA STATE PLANNING BOARD

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RAYMOND V. LONG, DIRECTOR

Shortly after this report was transmitted to the Governor of Virginia the Planning Board was advised that the Corps of Engineers had revised its estimate of costs on the Buggs Island Project, such revised estimate being based on increased costs of labor and materials entering into the construction. The same factors will also increase the average annual benefits when existing price indices are used in estimating the value. This revised estimate was received too late for incorporation in the body of this report.

The cost of the Buggs Island Dam Project as estimated by the Corps of Engineers in 1946 was $47,970,000, and is the estimate used in this report.

Those interested in reviewing the breakdown of the revised estimate of costs of the Buggs Island Project, amounting to $57,730,000, will find such breakdown and a brief discussion at the end of this report under Addenda, pages 153 to 156.

January 23, 1947

To the Honorable William M. Tuck
Governor of Virginia
Richmond, Virginia

Dear Governor Tuck:

The Virginia State Planning Board herewith transmits the Roanoke River Basin Report prepared by the River Basin Committee of the Planning Board, and expresses to you its grateful appreciation for your interest in recommending the appropriation and authorizing the transfer of funds necessary for this study and report.

Respectfully submitted
The Virginia State Planning Board
By Raymond V. Long, Director

REPORT
ON
THE PROPOSED DEVELOPMENT
ON THE
ROANOKE RIVER BASIN

BY

THE RIVER BASIN COMMITTEE

OF

THE VIRGINIA STATE PLANNING BOARD

River Basin Committee

Edward W. Saunders
Chairman
R. A. Marr, Jr.
Percy H. McGauhey
Benham E. Morriss

Price $0.50 per copy

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ROANOKE RIVER BASIN REPORT

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GIFT, RICHARD J. RICHARDSON

FOREWORD

The Virginia State Planning Board at its October, 1945 meeting recommended the preparation of a series of interpretive reports on the several river basin developments proposed by the Corps of Engineers. The reports would be widely distributed, and would serve to inform the people of Virginia of what is contemplated by these proposals. This recommendation was approved by Governor Colgate W. Darden and in December of 1945 a Committee of Engineers consisting of Edward W. Saunders, Professor of Civil Engineering, University of Virginia; R. A. Marr, Jr., Professor of Civil Engineering, Virginia Military Institute; Percy H. McGauhey, Professor of Sanitary Engineering, Virginia Polytechnic Institute, and representing the three State Engineering Schools was appointed by the Board, in consultation with the Governor. Benham E. Morriss, Planning Engineer with the State Planning Board served the Committee as Engineer-Secretary and is responsible for most of the research work for preparation of the manuscript, and for the direction of the preparation of the various maps, charts and tables.

The Committee has met regularly each month in reviewing, discussing and approving the report as its preparation has progressed. The report has been prepared in five sections for the convenience of those interested in certain aspects of the report rather than reading the entire report. The readers attention is called to Section V which discusses, in a nontechnical form, the project and how it affects the State of Virginia. Some sections are necessarily technical because of the considerations involved.

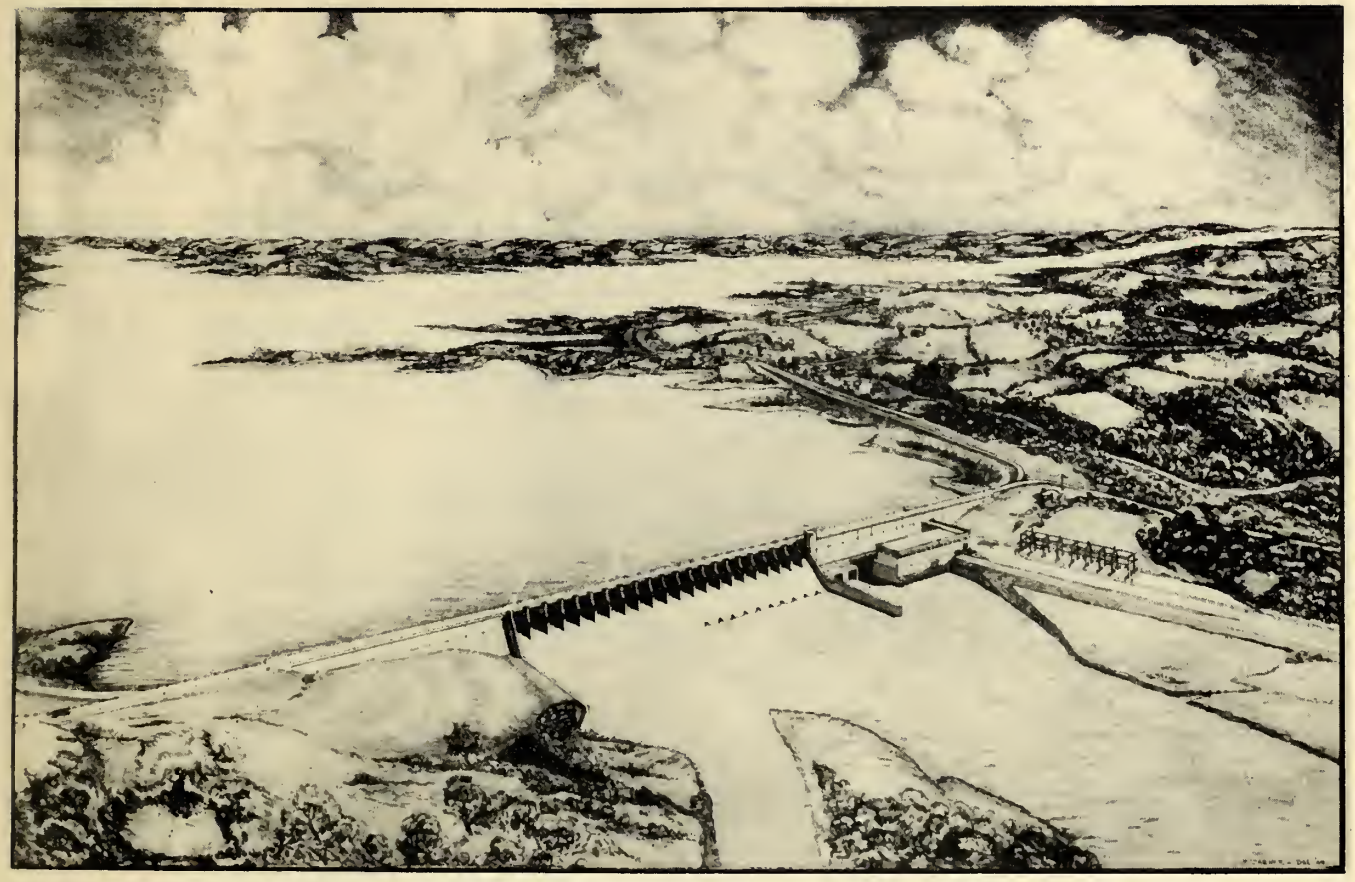
This is the first of a series of reports contemplated for the different river basins of Virginia. It is not an original engineering investigation but a condensed and interpretive report on the Review Report of the Corps of Engineers along with certain other pertinent information and data. Data from other sources have been assembled by this committee and numerous publications as listed on pages 160 and 161 consulted. The Federal Power Commission has furnished data on power values and markets.

The Committee does not attempt to formulate policy for river basin development, nor justify or criticize policy and procedure that have been followed in preparation of the proposal for development of the Roanoke River; these have been determined by the Congress. Neither does the Committee attempt to verify the adequacy of the Corps of Engineers' design nor the correctness of its cost estimates.

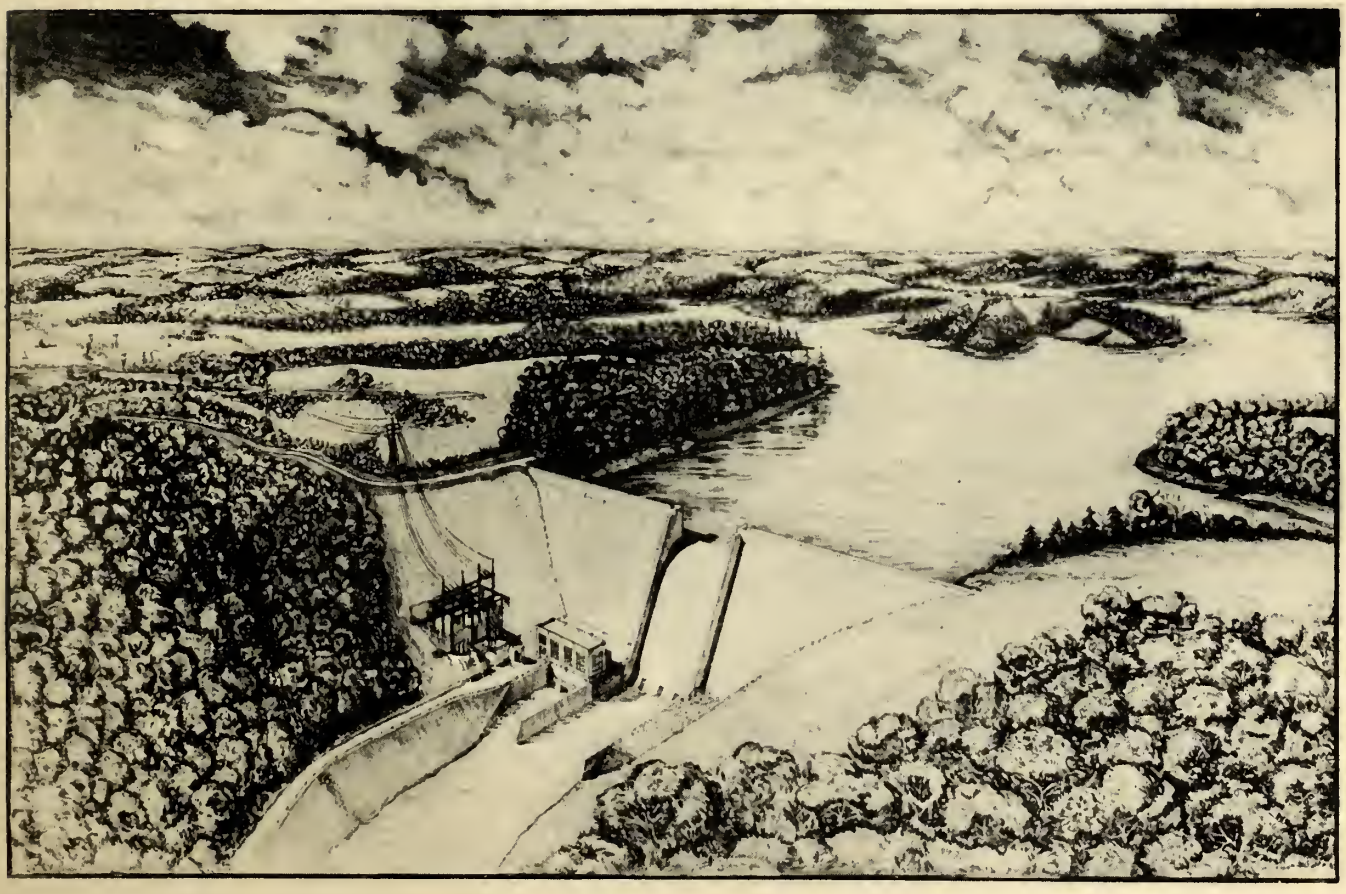
Much information has been compiled that could not be included in this condensed report. Technical data, and more detailed maps and information are on file in the offices of the Virginia State Planning Board and are available for study and review by interested groups or individuals.

The Virginia State Planning Board acknowledges its grateful appreciation to the Corps of Engineers for full cooperation and courtesy in furnishing information and other assistance in the preparation of the report; to the River Basin Committee and its Engineer-Secretary for their untiring efforts in the research, review and discussions necessary to the compilation of the report; and to other engineers and interested citizens for their advisory and generous consultation services.

The Virginia State Planning Board



BUGGS ISLAND PROJECT



PHILPOTT Nº 4 PROJECT

PICTURES FURNISHED BY U.S. ENGINEER OFFICE, NORFOLK, VIRGINIA

ROANOKE RIVER BASIN REPORT

SECTION I

INTRODUCTION

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REPORT ON THE ROANOKE RIVER BASIN

INTRODUCTION

RIVER BASIN DEVELOPMENT, GENERAL - The Federal Government, since its founding, has concerned itself with the development of the rivers of this country. The authors of the Constitution envisioned the need for overall regulation of commerce and incorporated the so-called Commerce Clause in the Constitution. This clause empowered Congress to regulate commerce with foreign nations, among the several states and with the Indian tribes. Because in the eighteenth century the rivers were the chief means of transportation and an avenue of commerce, early study and improvement began. This work consisted largely of navigation improvements of tidal streams but as people migrated westward such improvements were extended beyond the tidal range. In Virginia, the Federal Government surveyed the James River below Richmond in 1836. This is the earliest record of a study of a river in this State. In 1870, the Federal Government began a comprehensive program below Richmond with a channel 180 feet wide and 18 feet deep. Soon after, it began the improvement of other tidal rivers.

Above tidewater, private interests developed the James and some of its tributaries with a system of canals. Likewise private interests originally constructed canals on the Potomac and Rappahannock Rivers. On other rivers, shallow draft craft navigated above tidewater. In recent years, navigation above tidewater has been negligible and all of the navigation structures have been abandoned.

Until the disastrous Mississippi flood of 1927, the Federal Government concerned itself with flood control only as it pertained to navigation. It constructed the early levees on the Mississippi to confine the river to its navigation channel, and while these served for flood protection they also improved navigation and furthered commerce. The 1927 Flood Control Act empowered the Federal Government to construct flood control works and public opinion has now accepted flood control as a proper function of the Federal Government. Various decisions of the Supreme Court and acts of Congress have extended the Federal jurisdiction to all the major and minor watersheds of the country.

A small number of local flood protection projects have been constructed in Virginia, the largest being at Richmond. These have been financed locally, and protect from moderate floods only. They furnish inadequate protection against the maximum floods that may be expected. Claytor Reservoir is the only lake in Virginia that has an appreciable regulating effect. This lake is formed by a dam completed by the Appalachian Electric Power Company in 1939 and located on the New River near Radford, Virginia.

The Corps of Engineers now proposes plans for the development of the Potomac, Rappahannock, James, and Roanoke Rivers. These plans call for a series of dams, some of which will store water for flood protection, power generation, pollution abatement, and improvement of low water flow. Other dams will serve chiefly for power generation by utilizing the head available and the improved flow resulting from storage reservoirs.

The history of the country's river basins shows the growth of the interest of the Federal Government and the gradual expansion of the scope of improvements: first, navigation as an aid to commerce; second, flood control by coordinated improvement of a river; third, power generation as an added means of making the project self-liquidating; and fourth, as industrial activity increased, pollution abatement. As the number of good reservoir sites in any river basin are limited and any partial development of a river affects subsequent improvements, recent investigations have included all beneficial possibilities of water use. These complete investigations were made in an endeavor to secure maximum useful development of the water resources of the basin.

The right of the government to generate and market power in connection with its river improvements has been questioned, but this right has been upheld by the Supreme Court in its decisions. Two notable cases were the Ashwander Case in connection with Wilson Dam and the suit of the nineteen power companies against the Tennessee Valley Authority. The 1944 Flood Control Act set forth the policy of Congress by directing that all electric energy generated at the projects authorized in this act and which was not required in the operation of such projects be marketed by the Department of the Interior in such a manner as to encourage the most widespread use thereof.

House Document No. 308, 69th Congress, First Session, which was incorporated in the Rivers and Harbors Act, approved January 21, 1927, authorized the War Department to make a comprehensive study leading to the development of the major rivers of this country. This document authorized studies on the James, Roanoke, Rappahannock, Potomac and other rivers of the State. Although improvements studied under this authorization showed economical sources of water power, projects were not recommended for Federal development unless the improvements were justified economically by the benefits accruing from navigation, flood control, irrigation or a combination of these. The development of hydroelectric power was at that time considered a field for private development and the consideration given to water power in the reports submitted under the authorization of House Document No. 308 was for the purpose of determining that if any private hydroelectric developments were made, they would fit into the highest overall use of the stream.

Plate I outlines the principal river basins of the State.

During the past ten years, the Corps of Engineers has been instructed by Congress to continue the studies on many rivers and in these later studies to consider, in the economic justification of the development, the value of the power that could be sold. Such plans, aimed at a complete utilization of water resources, center around comparatively large reservoirs called "multiple-purpose". In such reservoirs, definite storage volumes are reserved for definite purposes.

DESCRIPTION OF MULTIPLE-PURPOSE PROJECT - A typical multiple-purpose reservoir is shown on Plate II and its components and operation are best understood by reference to this plate.

The storage space below the line designated "Minimum Power Pool Level" is kept filled continuously and therefore is of no value for regulation. It serves to supply head for power generation and as a storage space for a large percentage of the silt deposited in the reservoir. It maintains the minimum water surface available for boating, fishing and other recreational and conservation uses.

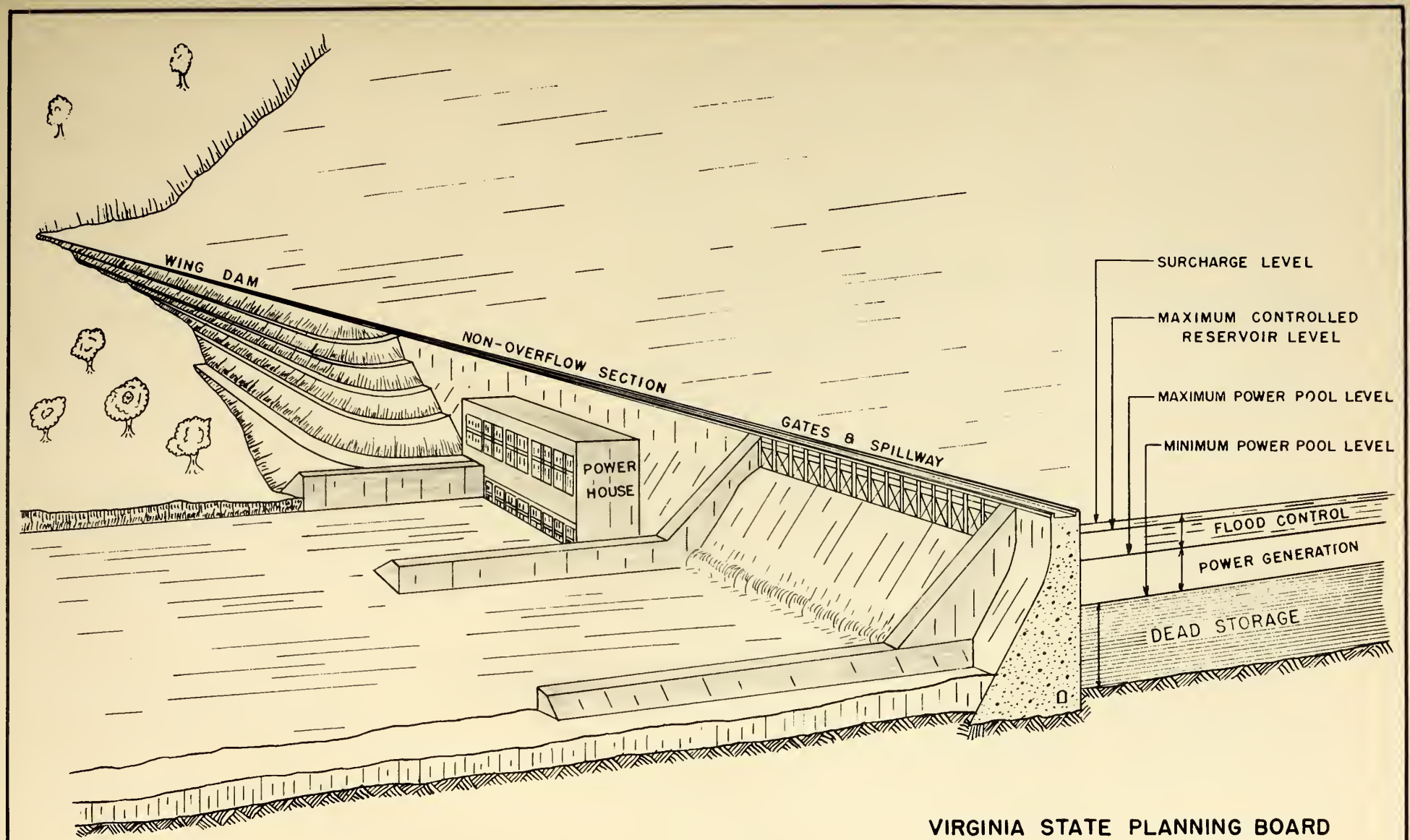
The storage space between the lines designated "Minimum Power Pool Level" and "Maximum Power Pool Level" is filled and emptied seasonally as required for power, navigation, pollution abatement, water supply and any other water uses served by the reservoir. During periods of high flow, a portion of the inflow to the reservoir is stored in this space. During dry seasons, when natural flows are lower than desirable, the water between these levels is released through the waterwheels in the power plant and the reservoir gradually drawn down to the "Minimum Power Pool Level". This water released from storage supplements the natural flow of the stream and not only generates power at the storage dam but also increases the energy output of all downstream hydroelectric plants. This increased flow also maintains greater depth for navigation, provides additional water supply and dilutes the stream pollution.

The storage space between the lines designated "Maximum Power Pool Level" and "Maximum Controlled Reservoir Level" is reserved for flood control. Between floods, this space is kept empty. During flood periods, water is stored in sufficient quantities to control the flow below the reservoir. As soon as conditions permit, the water stored in this space is released. The rate of release is held below the rate that would cause damage below the reservoir. These releases are through the waterwheels up to their capacity and are used to generate power. Additional flow in excess of the waterwheel capacity is released over the spillway or through the sluices. The space reserved for flood control is occupied by water only during flood periods and during the short subsequent time required to discharge the volume stored above the "Maximum Power Pool Level". This space is thus a detention basin to reduce the flood heights to such as would cause a minimum of damage.

The storage space between the lines designated "Maximum Controlled Reservoir Level" and "Surcharge Level" provides emergency storage. This space is above the top of gates and is reserved for storage of water in excess of the flood that the structure is designed to control. If such a flood should occur, the gates are opened to allow a discharge exceeding that which causes damage below the "multiple-purpose" dam. Water can then be stored in this space to prevent damage to the dam. Such operation may cause severe flood damage below the dam but it insures the structure against failure. The chance of occurrence of conditions that would require use of the surcharge is small and is usually estimated to occur once in a thousand years.

FINANCIAL JUSTIFICATION - By combining the benefits accruing from flood control, power generation, and increased low water flow for pollution abatement and navigation aid, a project may be economically sound, while if one or more of these were omitted, such might not be the case. These projects, to be acceptable, must be economically sound and produce a sufficient return on their investment to be self-liquidating. Flood control and increased low water flows do not bring in cash revenue but such improvements do materi-

plate I in envelope at end



VIRGINIA STATE PLANNING BOARD

RIVER BASIN COMMITTEE

ROANOKE RIVER BASIN STUDY

TYPICAL MULTIPLE PURPOSE RESERVOIR

SEPTEMBER 1946

HLW

PLATE II

ally benefit the residents below the dam. Private capital can only evaluate direct revenue-producing items, which in the case of the Virginia streams, is power development. Such capital cannot be profitably invested in properties that do not immediately become revenue-producing. Interstate characteristics of many basins and the magnitude of the expenditures place the development of such structures beyond the ability of most states. The Federal Government seems to be the only agency that can build for the future and in the development of a river basin integrate all aforesaid benefits into a system that may be economically justified and self-liquidating.

RIVER BASIN COMMITTEE - Governor Darden, in December, 1945, realizing the people of Virginia are concerned with public projects within their State, approved a recommendation of the Virginia State Planning Board, and authorized the Board to prepare and to submit reports to him and to the public on such projects. He further approved and authorized the formation of a River Basin Committee to prepare these reports for the State Planning Board. The Planning Board selected personnel from the three engineering schools of Virginia to constitute the committee. Governor Tuck authorized the continuation of this committee. This report describes briefly the proposed development of the Roanoke River. It is one of several dealing with the major rivers of the State. It is intended to be simple and relatively free from technical complexity and to help the people of the State to understand better the Roanoke River Development as now proposed by the Corps of Engineers. It offers no new ideas for this development and does not propose to check the engineering design of the projects, but rather to offer an interpretive study of the report of the Corps of Engineers and to answer some of the questions generally asked by the public. The report in no way attempts to interpret the flood control policy of the Federal Government. This policy is determined by the Congress and expressed in the laws passed by that body.

ROANOKE RIVER BASIN REPORT

SECTION II

ROANOKE RIVER BASIN DEVELOPMENT

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ROANOKE RIVER BASIN DEVELOPMENT

AUTHORIZATION - House Document No. 308 of the 69 th Congress, First Session, adopted January 21, 1927, authorized preparation of comprehensive plans for the development of a number of rivers. The Roanoke River was included in this authorization. In compliance with this document, the Corps of Engineers conducted a survey of the Roanoke River and forwarded to Congress on November 16, 1934, a report which was published as House Document No. 65 of the 74th Congress, First Session. This report was unfavorable to a comprehensive plan for the development of the Roanoke River. Briefly the Corps of Engineers concluded that existing improvements adequately satisfied navigation requirements below Weldon, N. C., and that navigation above Weldon was not practical. As for power, they investigated a number of sites and found several to be capable of development with financial success when and if a power market existed. No such market existed at the time of the report. The District Engineer did not consider the flood problem serious and could devise no economical plan for flood control. He found no way at that time and under the then existing conditions to coordinate economically power and flood control nor could these be coordinated with navigation.

Subsequently, the 74th Congress by Public Act No. 738 (approved June 22, 1936) and the 75th Congress by Public Act No. 761 (approved June 28, 1938) authorized further study of the Roanoke River and its tributary, the Smith River. Resolutions by the Committee on Flood Control (adopted August 28, 1940) and by the Committee on Rivers and Harbors (adopted January 26, 1942) both of the House of Representatives, directed the Board of Engineers for Rivers and Harbors to review House Document No. 65. In compliance with these instructions from Congress the Corps of Engineers prepared a Review Report on the Roanoke River which was submitted to Congress on May 30, 1944, and published as House Document 650 of the 78th Congress, Second Session. Congress adopted this report in Public Act 534 of the 78th Congress, which authorized construction of the Buggs Island Project on the Roanoke River, approximately 179 river miles upstream from the mouth and 20 miles downstream from Clarksville, Virginia, and the Philpott Project on the Smith River, 44 miles above the mouth of that stream. The adopted comprehensive development included eight projects on the Roanoke River, two projects on the Smith River and one project on the Dan River but authorized for early construction only the two mentioned above. The Federal Power Commission advised Congress that energy generated at these two projects could be marketed in the region in the foreseeable future.

In nearly all cases where reports were submitted under instructions of House Document No. 308, the Corps of Engineers did not recommend development unless it could be economically justified by flood control, navigation, irrigation or a combination of these three. In subsequent reviews of such reports, they usually recommended that improvement be authorized if a combination of the above benefits with others such as power, pollution abatement, improved low water flow, etc., showed the projects to be economically sound.

The recommendations contained in House Document 650 were also influenced by the large floods that occurred in October 1937 and August

1940, and their resulting damage. Previous to these, flood records on the Roanoke River were rather sketchy and the estimation of flood damage difficult.

The study of the Roanoke River Basin by the Corps of Engineers, as outlined in the preceeding four paragraphs, in general followed the usual Federal pattern, which is as follows:

1. Congress authorizes "preliminary examination and survey" in a flood control act.
2. A preliminary examination is made by the District Engineer and reviewed by the Division Engineer and the Board of Engineers for Rivers and Harbors. This report makes recommendations on the advisability of undertaking a "survey". If the report on the preliminary examination is unfavorable, it is transmitted to Congress. If it is favorable, a "survey" is authorized by the War Department without further Congressional action.
3. A "survey" report is made by the District Engineer, reviewed by the Division Engineer, the Board of Engineers for Rivers and Harbors, and the Chief of Engineers. It is transmitted to Congress by the Secretary of War. This report makes recommendations on the advisability of constructing a project. Congress may or may not authorize construction in a flood control act. (House Document No. 65, 74th Congress, First Session, was a "survey" report.)
4. "Review" reports are authorized by a resolution of a Congressional committee and may be either "preliminary examination" or "survey" in scope. (House Document No. 650, 78th Congress, Second Session, is a "review" report of survey scope.) The recommendations contained in House Document No. 650 were incorporated in a bill by the Congressional Committee on Flood Control after public hearings before this committee. The bill was enacted into law and construction authorized by an Act of Congress. (Public Act 534 of the 78th Congress, approved December 22, 1944.) Before any construction could be undertaken, a further act of Congress, following additional committee hearings, appropriated funds to the project.

DESCRIPTION OF THE PROJECTS - Plate III is a map of the Roanoke River Basin on which have been indicated the proposed dams with their order of construction and the existing primary highways and railroads. Plates IV and V are profiles of the river with the projects shown in cross-section.

Buggs Island Project has been authorized by Congress and an appropriation has been made to begin construction. Philpott No. 4 Project has been authorized and an appropriation made for engineering and detail plans but no appropriation has been made for construction. The remaining nine projects are included in the adopted comprehensive development but their construction is not authorized. Preliminary studies only have been made.

Below is a brief description of Buggs Island and Philpott No. 4 Projects and a list of the other nine projects included in the adopted plan. Table I contains supplemental information on all of the projects. The data contained in the description of the Buggs Island Project and the portion of Table I

which applies to that project were supplied by the Corps of Engineers in "Pertinent Data", dated March 13, 1946. The data on all other projects were taken from House Document No. 650, dated June 6, 1944.

BUGGS ISLAND

The dam site is located on the Roanoke River in Mecklenburg County, Virginia, 178.7 miles above the mouth, 18 miles upstream from the Virginia-North Carolina boundary and 20.3 miles downstream from Clarksville, Virginia. The dam consists of a concrete gravity gate controlled spillway section 1,150 feet long and a concrete gravity non-overflow section 1,647 feet long. The maximum height is 144 feet. The concrete sections are connected to high ground by earth dikes 9,100 feet long on the right bank and 10,600 feet long on the left bank. The maximum height of earth fill is 45 feet. The spillway will have a maximum discharge capacity of 770,000 cubic feet per second with a pool elevation of 325. The drainage area above the dam site is 7,800 square miles.

The reservoir at maximum flood control pool elevation of 320 inundates a total of 87,900 acres which are located as follows:

State	Total Acres	Cleared Acres
Virginia	63,420	19,680
Mecklenburg Co.	46,760	15,000
Halifax Co.	14,500	3,900
Charlotte Co.	2,160	780
North Carolina	24,480	6,630
Total Virginia and North Carolina	87,900	26,310

The reservoir at elevation 320, which is the maximum exclusive of surcharge, extends 56 miles up the Roanoke River to the vicinity of Randolph, Virginia, and 34 miles up the Dan River to the vicinity of South Boston, Virginia. The estimated total acreage to be acquired is 107,900. It will affect three schools already scheduled for closing and consolidation, sixteen miles of primary highways, fourteen miles of secondary highways, twenty-two miles of railroads, forty-seven miles of transmission and distribution lines, thirty-eight miles of telephone and telegraph lines, two miles of pipe lines, and cemeteries containing 2,100 graves. At elevation 325, the reservoir has a total storage of 3,392,000 acre-feet or 8.15 inches of runoff over the drainage area. This storage is divided as follows:

		Acre-feet	Inches of Runoff
Uncontrolled Flood Storage	(Elev. 325 to 320)	471,000	1.13
Controlled Flood Storage	(Elev. 320 to 300)	1,345,000	3.23
Power Storage	(Elev. 300 to 268)	1,085,000	2.61
Unusable Storage	(Below elev. 268)	491,000	1.18

The reservoir is designed to reduce the 1940 record flood flow of 270,000 cubic feet per second below Buggs Island to 60,000 cubic feet per second.

VIRGINIA STATE PLANNING BOARD
RIVER BASIN COMMITTEE

ROANOKE RIVER BASIN STUDY

PROFILE - ROANOKE RIVER

SEPTEMBER 1946

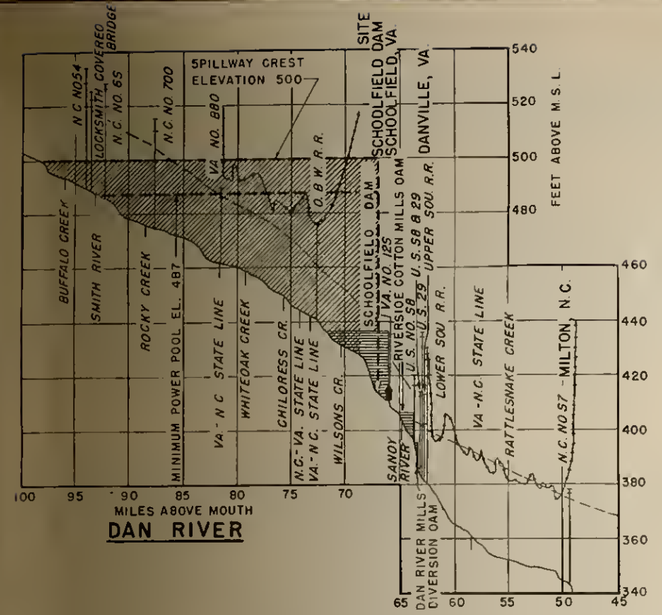
NOTE: DATA FROM PLATE 3, REVIEW REPORT, CORPS OF ENGINEERS AND "PERTINENT DATA" BUGGS ISLAND RESERVOIR, DATED MARCH 13, 1946.

VIRGINIA STATE PLANNING BOARD
RIVER BASIN COMMITTEE

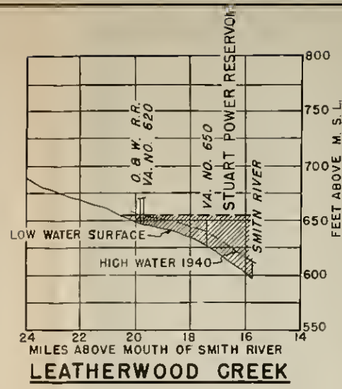
ROANOKE RIVER BASIN STUDY

DAN AND SMITH RIVER PROFILES

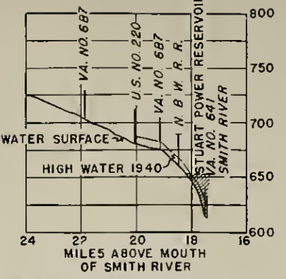
SEPTEMBER 1946



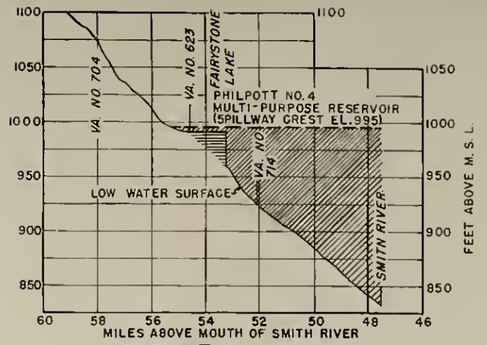
DAN RIVER



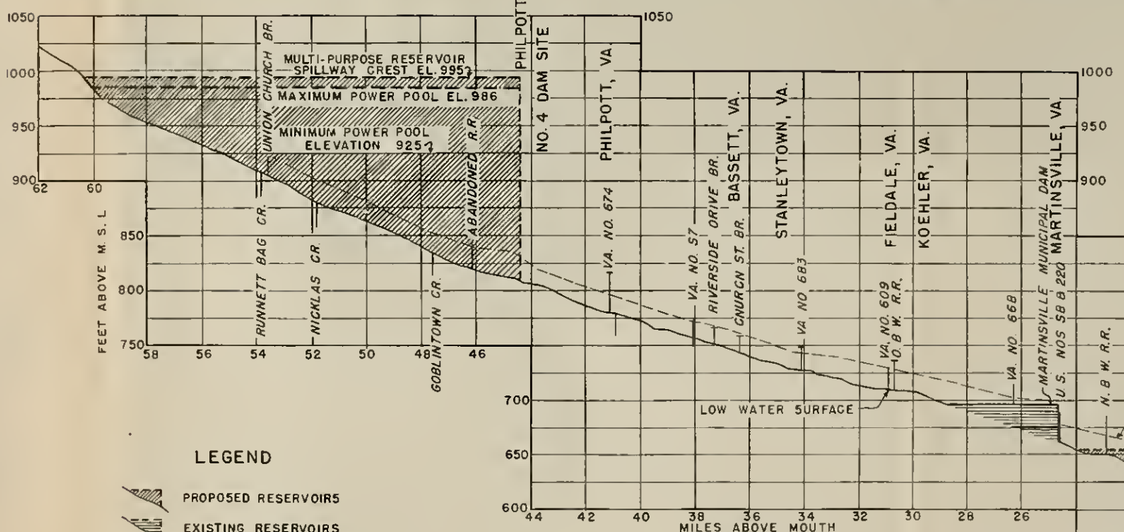
LEATHERWOOD CREEK



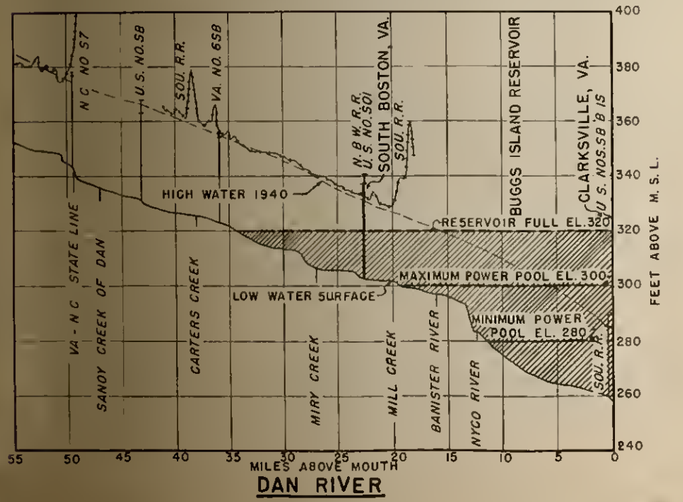
MARROWBONE CREEK



GOBLINTOWN CREEK



SMITH RIVER

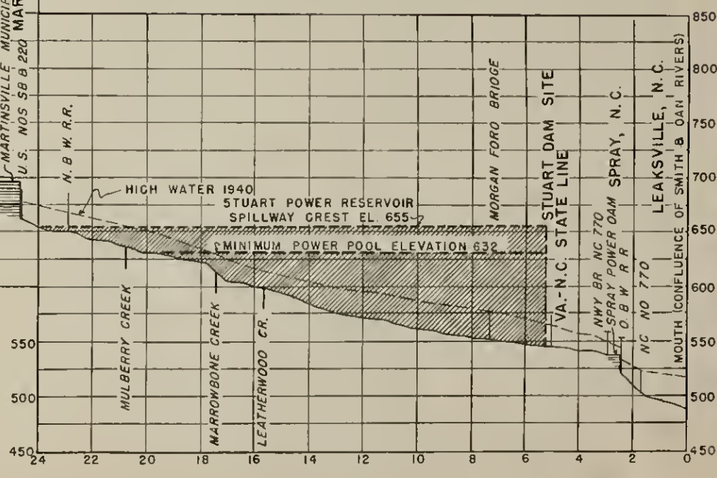


DAN RIVER

LEGEND

- PROPOSED RESERVOIRS
- EXISTING RESERVOIRS
- HIGH WATER 1940
- LOW WATER SURFACE
- RAILROAD
- POWER CONDUIT
- BRIDGE (DECK / LOW STEEL)
- EXISTING POWER DEVELOPMENT
- PROPOSED POWER DEVELOPMENT

NOTE: DATA FROM PLATE 4 AND 5, REVIEW REPORT, CORPS OF ENGINEERS AND "PERTINENT DATA" BUGGS ISLAND RESERVOIR, DATED MAR. 13, 1946.



The initial installation for power generation consists of three units of 32,000 kilowatts each, one unit of 12,000 kilowatts, and station service units. The ultimate installation will have three additional units of 32,000 kilowatts each. The initial installation is estimated to produce 200,000,000 kilowatt-hours per year for a critically dry year such as 1930 and 410,000,000 kilowatt-hours for the average year.

The Buggs Island Project, in addition, increases the stream flow during periods of low discharge and increases the value of the two proposed down river plants (Gaston and Roanoke Rapids) by increasing the valuable primary power output. During the critical dry period of 1930-31, the minimum flow of record at Gaston Dam site was 485 cubic feet per second. The regulation supplied by Buggs Island would provide an average, during a similar critical period, of 4,300 cubic feet per second. It has a like effect at Roanoke Rapids. These two plants when operated in coordination with Buggs Island, are capable of producing much larger quantities of firm energy than they could produce without the regulation of flow supplied by Buggs Island.

PHILPOTT NO. 4

The dam site is located on the Smith River in Franklin and Henry Counties, Virginia, 44.3 miles above its mouth, 7.0 miles upstream from Bassett, Virginia, and 3.4 miles above the mouth of Town Creek. The preliminary design as given in House Document 650, dated June 6, 1944, called for a rolled earth embankment having a maximum height of 214 feet and a length of 945 feet. There is a 24 foot inside diameter tunnel in the right abutment which will be used during construction to divert the river and after completion of the dam to discharge the flood waters impounded between the crest of the spillway and the maximum power pool elevation. The spillway is a side hill type, ungated, 130 feet wide, and located about 2,000 feet north of the dam. The designed maximum capacity of the spillway is 31,000 cubic feet per second. The drainage area above the dam site is 212 square miles.

The reservoir at spillway crest elevation of 995 inundates 3,900 acres in Franklin, Henry, and Patrick Counties, Virginia. The estimated acreage to be acquired approximates 5,000. The reservoir area is sparsely inhabited. One highway will be affected for about three quarters of a mile. There are no railroads and a very small amount of public utilities in the area. At elevation 1,013 the reservoir has a total storage of 317,000 acre-feet or 28 inches of run-off over the drainage area which is divided as follows:

		Acre-feet	Inches of Runoff
Uncontrolled Flood Storage	(Elev. 1,013 to 995)	77,000	6.81
Controlled Flood Storage	(Elev. 995 to 986)	34,000	3.01
Usable Power Storage	(Elev. 986 to 925)	133,500	11.81
Storage Reserved for Low Water Regulation		6,600	0.58
Unusable Storage	(Below elev. 925)	65,900	5.83

The reservoir will reduce a flood such as that of October, 1937, (the largest of recent record) from a peak flow of 29,600 cubic feet per second to an inconsequential out-flow.

The installation for power generation will consist of two units of 4,500 kilowatts each estimated to produce annually 22,400,000 kilowatt-hours of prime energy and 1,200,000 kilowatt-hours of secondary energy.

The final design of the Philpott No. 4 Project will probably differ considerably from the preliminary design. A concrete gravity spillway section, ungated, is being considered. This will be constructed at the same location as the earth embankment and the crest will be approximately 10 feet lower than the side hill spillway crest. If this design is adopted, the power house will be located at the dam and will be connected with the lake by short intakes.

With the spillway crest at 985, the storage reservations are estimated by the River Basin Committee as follows:

		Acre-feet	Inches of Runoff
Uncontrolled Flood Storage	(Elev. 1,004 to 985)	77,000	6.81
Controlled Flood Storage	(Elev. 985 to 975)	34,000	3.01
Usable Power Storage	(Elev. 975 to 925)	103,000	9.11
Unusable Storage	(Below elev. 925)	66,000	5.83

The final elevations selected may differ from this estimate which is based on the same volumes for flood control storage and unusable storage as that given in House Document No. 650.

ADOPTED BUT NOT AUTHORIZED PROJECTS

The other projects included in the adopted program are listed below in the order of priority for construction that has been assigned by the Corps of Engineers. None of the following projects has been authorized for construction by Congress.

Project	River	Miles Above Mouth	Order of Construction
Gaston	Roanoke	145	3
Roanoke Rapids	Roanoke	138	4
Smith Mountain	Roanoke	314	5
Leesville	Roanoke	294	6
Taber	Roanoke	275	7
Melrose	Roanoke	263	8
Randolph	Roanoke	228	9
Stuart	Smith	5	10
Schoolfield	Dan	67	11

TABLE I - PROJECT DATA

ITEM	AUTHORIZED PROJECTS		APPROVED BUT NOT AUTHORIZED PROJECTS									
	Bugge Ieland	Pilpott No. 4	Gaeton	Roanoke Rapids	Smith Mountain	Leesville	Taber	Melrose Development		Randolph	Stuart	Schoolfield
								Melrose	Whipping Creek			
Purpose	Multipurp.	Multipurp.	Power	Power	Power	Power	Power	Power	Power	Power	Power	Power
Location - River	Roanoke	Smith	Roanoke	Roanoke	Roanoke	Roanoke	Roanoke	Roanoke	Whipping	Roenoke	Smith	Dan
Miles above Mouth	178.7	44.3	144.9	137.5	314.2	293.7	275.0	262.9	1.0	227.8	5.3	67.0
State	Ve.& N.C.	Va.	Ve.& N.C.	N.C.	Va.	Va.	Va.	Va.	Va.	Va.	Va.& N.C.	Va.& N.C.
Drainage Area - Square Miles	7,800	212	8,339	8,395	1,020	1,497	2,249	2,370	19	2,982	534	1,890
Type of Dam	Conc.-Earth	Earth	Conc.-Earth	Concrete	Concrete	Conc.-Earth	Concrete	Conc.-Earth	Earth	Conc.-Earth	Earth	Conc.-Earth
Type of Spillwey	Geted	Ungated	Geted	Geted	Ungated	Geted	Geted	Gated	Ungated	Ungeted	Ungated	Ungated
Max. Height Dam, Feet	144	214	108	79	244	95	54	110	96	147	138	126
Creet Length, Feet	22,500	945	2,730	2,900	750	1,050	930	1,630	1,500	1,760	1,340	2,040
Top of Dam, Elevetion, M.S.L.	332	1,020	212	147	814	610	534	510	498	415	678	527
Top of Getes, Elevation, M.S.L	320	Ungeted	200	127	Ungated	597	525	486	Ungated	Ungated	Ungated	Ungated
Crest of Spillwey, Elevetion, M.S.L.	288	995	180	115	780	572	501	466	486	380	655	500
Flowe at Dam Sites (Cubic Feet per Second)												
Natural Flow												
Average Annual Flow	7,850	252	8,520	8,570	976	1,430	2,160	2,280	--	2,870	635	2,080
Maximum of Record	270,000	22,600	267,000	261,000	70,000	96,000	120,000	128,000	--	155,000	38,000	70,000
Minimum of Record	467	40	485	487	96	135	195	200	--	252	100	160
Reguleted Flow												
Average for Power	6,850	227	7,470	7,510	878	1,286	1,935	--	2,034	2,574	571	1,836
Flowe for Spillway Design (Cubic Feet per Second)												
Reservoir Inflow	1,000,000	150,000	535,000	535,000	196,000	130,000	290,000	320,000	--	440,000	150,000	300,000
Reservoir Outflow	770,000	31,000	535,000	535,000	34,000	125,000	250,000	300,000	7,400	212,000	100,000	277,000
Reservoir Elevations (M.S.L.)												
Max. Elev. (Design Flood)	325	1,013	205	142	808	599	535	496	494	406	672	521
Elev. Top of Flood Control Pool	320	995	--	--	--	--	--	--	--	--	--	--
Elev. Max. Power Pool	300	986	200	127	780	597	525	486	486	380	655	500
Elev. Min. Power Pool	268	925	198	125	734	596	522	485	478.5	367	632	487
Max. Drawdown, Feet	32	61	2	2	46	1	3	1	7.5	13	23	13
Storage, Flet Pool Assumption												
Surcharge, Acre-Feet (A)	471,000	77,000	88,000	71,000	565,000	5,700	26,000	38,400	--	514,000	98,000	282,000
Controlled Flood Storage, Acre-Feet	1,345,000	34,000	0	0	0	0	0	0	0	0	0	0
Useble Power Storage, Acre-Feet	1,085,000	133,500	39,000	7,100	520,000	2,800	5,500	3,100	8,400	150,000	85,000	100,000
Totel Storage, Acre-Feet (B)	2,921,000	240,000	432,000	50,700	825,000	76,900	34,000	78,600	42,200	305,000	163,000	248,000
Lands end Acquisitions (Acres)												
Aree to be Acquired	107,900	4,300	19,950	4,780	19,950	3,340	2,415	3,680	1,700	20,170	6,125	12,835
Aree, Maximum Power Pool	51,200	3,400	19,800	3,800	16,200	3,000	2,200	3,500	1,300	14,500	4,800	9,200
Cleared Area below Max. Power Pool	15,100	1,000	6,600	1,500	5,400	2,600	1,900	2,500	600	5,800	1,200	4,600
Aree Inundeted, Max. Flood Control Pool	87,900	3,900	--	--	--	--	--	--	--	--	--	--
Aree to be Cleared	25,000	1,300	13,000	2,135	6,700	190	328	990	800	3,645	1,988	2,675
Aree to be Partly Cleared	10,800	--	--	--	4,900	290	--	--	--	5,130	1,736	2,675
Alteretions and Relocetions												
Highway Alteretione, Pieces	30*	1	18	8	11	5	1	5	3	11	11	11
Highweys Abendoned, Piece	19	0	0	1	17	2	0	0	0	5	2	2
Railroed Alteretions, Miles	22	0	0	1	--	--	4	10	--	4	--	10

(A) Storage above spillwey crest or top of gatee, for epillway design flood. (B) Below top of gates or crest of ungeted dam.
Dete for Buggs Island Project taken from "Pertinent Date," dated March 13, 1946 and supplied by Corps of Engineers.
All other date taken from House Document No. 650, dated June 6, 1944 and data distributed at hearing held at South Hill, Va., December 5, 1945.
M.S.L. denotes Mean See Level. * Milee to be altered.

ROANOKE RIVER BASIN REPORT

SECTION III

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ECONOMIC DEVELOPMENT

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DESCRIPTION OF THE ROANOKE RIVER BASIN

GEOGRAPHY - The Roanoke River Basin is located in the south central portion of Virginia and the northern edge of North Carolina. It drains all or parts of the following Virginia counties: Floyd, Patrick, Montgomery, Roanoke, Franklin, Henry, Pittsylvania, Bedford, Botetourt, Appomattox, Campbell, Charlotte, Halifax, Mecklenburg, and Brunswick. The basin is approximately 220 miles long and from 10 to 100 miles wide. Above Clarkesville, the Roanoke River is locally referred to as the Staunton River to the mouth of the Pigg River and as the Roanoke River upstream from this tributary. Its location is shown on Plates I and III.

DRAINAGE - The total drainage area of the Roanoke River is 9,580 square miles, of which 6,160 square miles are in Virginia. The principal tributary is the Dan which has a drainage area of 3,855 square miles and enters the Roanoke at Clarksville, Virginia.

TOPOGRAPHY - The physiographic provinces of the Roanoke River Basin are shown on Plate VI. A small portion of the western part of the basin lies in the Valley and Ridge Province and the Blue Ridge Province.

The Blue Ridge Province consists of the rugged mountain range of that name with elevations ranging up to 3,000 feet above sea level. The Valley and Ridge Province consists of the valleys and somewhat lower ridges extending to the parallel Alleghany Mountains. This terrain is rugged and the streams confined to narrow, steep valleys.

East of the mountains, the major portion of the basin lies in the Piedmont Plateau, ranging from steep to rolling country with elevations from 150 to 900 feet above sea level. Numerous tributary streams cut through the highlands. The flood plains on the main rivers vary from 1400 to 2000 feet in width. Below the fall zone, or eastern escarpment of the Piedmont Plateau, at Roanoke Rapids, N. C., the basin lies on the flat, featureless Coastal Plain. The flood plain varies from 1 to 6 miles in width and the tributaries are shallow and meandering.

No natural lakes exist in the basin and the numerous artificial reservoirs are small.

GEOLOGY - Geological formations vary widely. In the Blue Ridge Province, mica gneiss is the principal rock. On the Piedmont Plateau, the old sedimentary and igneous rocks have been so greatly altered that they have almost lost their identity. With some exceptions, these rocks are crystalline types of complex schists, gneisses, and granites. There is a narrow belt of Triassic shales, sandstones and conglomerates. The rich soil-producing limestones are found only west of the Blue Ridge.

The Coastal Plain consists of beds of sedimentary gravel, sand, clay, and marl. Crystalline rocks occur at depth of a few feet at the fall line and at considerable depth at the mouth of the river.

ECONOMIC DEVELOPMENT

POPULATION - In the Review Report the Corps of Engineers estimated the population of the Roanoke River Basin at 663,000: 433,000 in Virginia and 230,000 in North Carolina. In 1930, 56 per cent of the population of the basin was classed as rural farm and 27 per cent lived in cities or towns of 2,000 or larger.

For comparsion with other sections, data have been assembled for 15 counties and 5 cities in Virginia. This area will be referred to hereafter as the Roanoke River Region and consists of the following counties: Appomattox, Bedford, Botetourt, Brunswick, Campbell, Charlotte, Floyd, Franklin, Halifax, Henry, Mecklenburg, Montgomery, Patrick, Pittsylvania, and Roanoke: and the following cities: Lynchburg, Martinsville, Radford, Danville, and Roanoke. The Roanoke River and its tributaries drain all or a part of these counties, although some of the cities are outside the basin but adjacent thereto. Similar data have been assembled for the State of Virginia alone and for the following eight states: Alabama, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia. The area composed of these eight states will be referred to, in this report, as the Southeastern Region.

Data on population are given in Table II.

Per cent of change of population since 1920 is plotted on Chart I.

Chart I, Figure 1 for the period from 1920 to 1940, shows similar increasing trends in percentage gain in total population for the Roanoke River Region, Virginia, and the Southeastern Region. For 1943, this percentage gain continues to increase for Virginia but for the other two regions a recession is observed. This is doubtless explained by war efforts centering in and adjacent to Virginia. Figure 2 shows that urban percentage gains for the two regions have been somewhat greater than for Virginia during the period 1920 to 1940.

NATURAL RESOURCES - The Roanoke River Basin is not highly endowed with mineral resources. While many minerals are found, their quantity, development, and commercial importance are not great. There has been a moderate production of mica, granite, coal, stone, sand, and gravel. Stone is quarried and crushed at Roanoke and Danville, Va., and Henderson, N. C., and gravel pits are developed at Garysburg, N. C. Structural clay products are produced in several localities.

INDUSTRIAL DEVELOPMENT - Numerous products are manufactured in the basin, the principal ones being textiles, furniture, pulp, and building materials. The largest industrial centers are Roanoke and Danville, Va., and Roanoke Rapids, N. C. In recent years, the cities and towns along the Smith River have experienced a large industrial development which has resulted in an increasing demand for water for manufacturing processes.

On page 36 is the Corps of Engineers' estimate of industrial activities for the Roanoke River Basin as given in the Review Report.

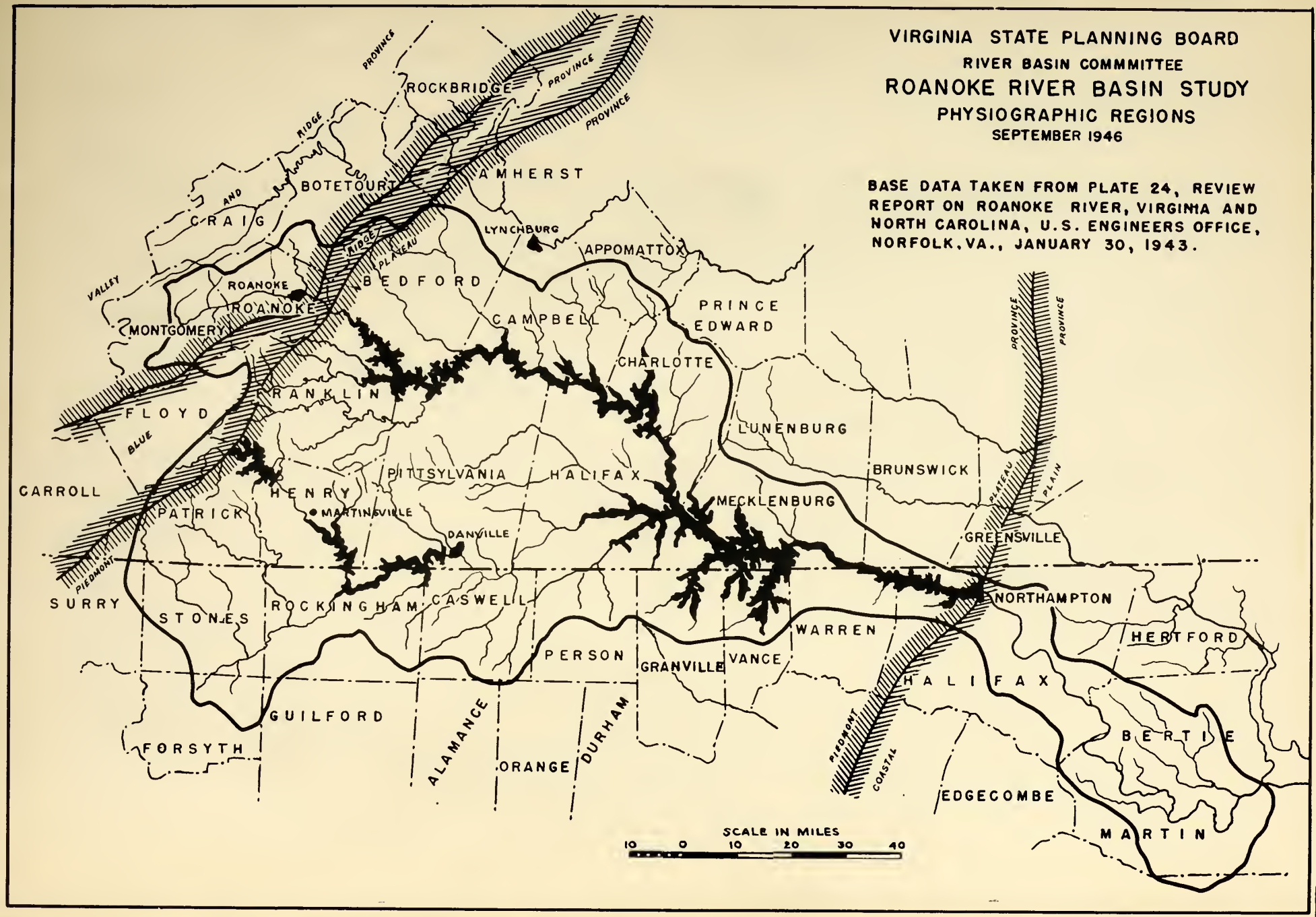

VIRGINIA STATE PLANNING BOARD
RIVER BASIN COMMMITTEE
ROANOKE RIVER BASIN STUDY
PHYSIOGRAPHIC REGIONS
SEPTEMBER 1946
BASE DATA TAKEN FROM PLATE 24, REVIEW REPORT ON ROANOKE RIVER, VIRGINIA AND NORTH CAROLINA, U.S. ENGINEERS OFFICE, NORFOLK, VA., JANUARY 30, 1943.
PROVINCE
ROCKBRIDGE
PROVINCE
RIDGE
AND
VALLEY
PROVINCE
BOTETOURT
AMHERST
CRAIG
LYNCHBURG
RIDGE
PLATEAU
APPOMATTOX
BEDFORD
ROANOKE
ROANOKE
MONTGOMERY
CAMPBELL
PRINCE EDWARD
CHARLOTTE
FRANKLIN
FLOYD
BLUE
LUNENBURG
PROVINCE
PROVINCE
BRUNSWICK
PITTSYLVANIA
HALIFAX
CARROLL
HENRY
MARTINSVILLE
PATRICK
MECKLENBURG
PLATEAU
PLAIN
DANVILLE
GREENSVILLE
PIEDMONT
SURRY
STONES
ROCKINGHAM
CASWELL
NORTHAMPTON
WARREN
HERTFORD
PERSON
GRANVILLE
VANCE
HALIFAX
GUILFORD
ALAMANCE
ORANGE
DURHAM
FORSYTH
PIEDMONT
COASTAL
BERTIE
EDGECOMBE
MARTIN
SCALE IN MILES
10 0 10 20 30 40
PLATE VI

TABLE II- POPULATION, URBAN AND RURAL DISTRIBUTION AND GROWTH, 1920-1943

	1920			1930			1940			1943**
	TOTAL	URBAN	RURAL	TOTAL	URBAN	RURAL	TOTAL	URBAN	RURAL	TOTAL
POPULATION										
Roanoke River Region	475,391	125,672	349,719	520,561	163,043	357,518	560,214	184,983	375,231	516,888
15 Counties	364,238	14,519*	349,719	374,515	16,997*	357,518	396,567	21,336*	375,231	--
5 Cities	111,153	111,153	0	146,046	146,046	0	163,647	163,647	0	--
Virginia	2,309,187	673,984	1,635,203	2,421,851	785,537	1,636,314	2,677,773	944,675	1,733,098	2,769,828
Southeastern Region	18,341,173	4,180,407	14,160,766	20,126,612	5,640,643	14,485,969	22,051,148	6,624,125	15,427,023	20,965,062
RURAL-URBAN PERCENTAGE DISTRIBUTION										
Roanoke River Region	100.0	26.4	73.6	100.0	31.3	68.7	100.0	33.0	67.0	--
15 Counties	100.0	4.0	96.0	100.0	4.5	95.5	100.0	5.4	94.6	--
5 Cities	100.0	100.0	--	100.0	100.0	--	100.0	100.0	--	--
Virginia	100.0	29.2	70.8	100.0	32.4	67.6	100.0	35.3	64.7	--
Southeastern Region	100.0	22.8	77.2	100.0	28.0	72.0	100.0	30.0	70.0	--
INDEX OF GROWTH										
Roanoke River Region	100.0	100.0	100.0	109.5	129.7	102.2	117.8	147.2	107.3	108.7
15 Counties	100.0	100.0	100.0	102.8	117.1	102.2	108.9	147.0	107.3	--
5 Cities	100.0	100.0	--	131.4	131.4	--	147.2	147.2	--	--
Virginia	100.0	100.0	100.0	104.9	116.6	100.1	116.0	140.2	106.0	119.9
Southeastern Region	100.0	100.0	100.0	109.7	134.9	102.3	120.2	158.4	108.9	114.3
ROANOKE RIVER REGION AS PERCENT OF										
Virginia	20.6			21.5			20.9			18.7
Southeastern Region	2.6			2.6			2.5			2.5

*Towns over 2,500
**Estimated civilian population

Source: 1920 -- 14th Census of the United States
1930 - 15th Census of the United States
1940 - 16th Census of the United States
1943 - County Basic Data, Published by Market Research Dept. Farm Journal, Inc., Philadelphia, Approved by the Bureau of Foreign and Domestic Commerce

Year	No. of Establishments	No. of Employees	Annual Wage	Value of Manufactured Products
1919	1,246	29,599	$27,289,977	$136,538,751
1929	668	36,652	34,327,767	239,454,419
1939	519	45,006	34,884,086	232,827,333

The above statistics are not entirely comparable as U. S. Census methods were changed between 1919 and 1929. In 1919 the census covered all establishments having an annual value of products of $500 or more, while in later years $5,000 was the lower limit.

The basin has a favorable climate, labor conditions are generally good, and transportation facilities are adequate. These factors should assist the region in its industrial development. Existing and potential electric power supply will support a larger industrial activity. Minimum stream flows are generally adequate for present industrial needs but large developments on the smaller streams could result in shortages.

Data on manufactured products for the Roanoke River Region, Virginia and the Southeastern Region are given in Table III.

The percentages of wage earners, wages paid, and value of output are indicated on Chart II.

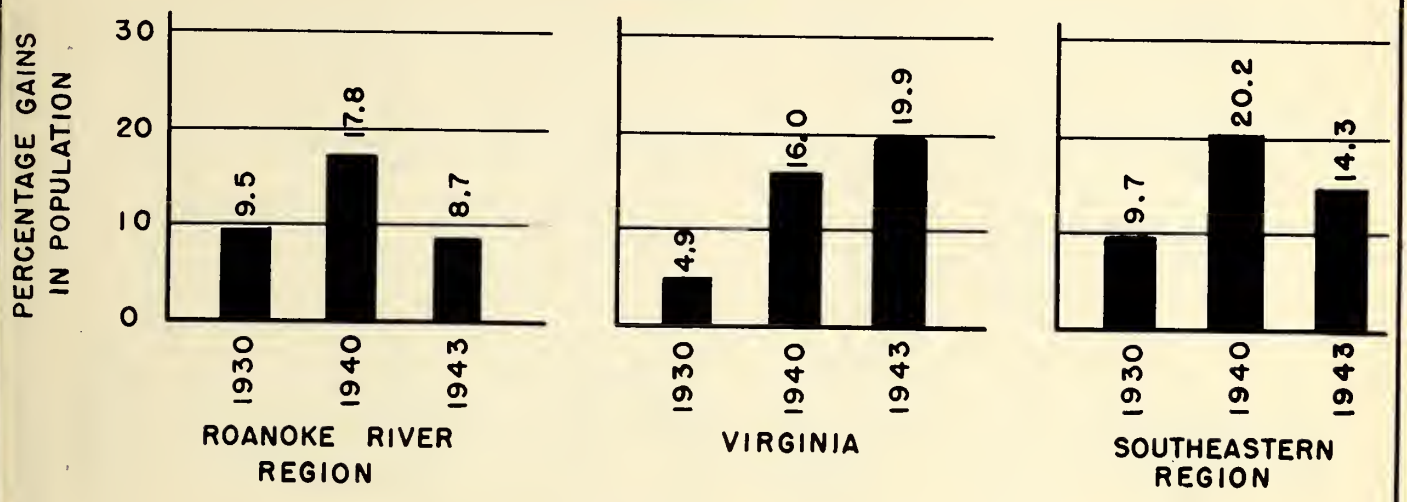
It should be noted from Figure 1 that the change in the value of the output in the Roanoke River Region is nearly the same as the change for Virginia. However the number of wage earners in the Region and their wages increased faster than in the State as a whole, the increase being particularly large in the decade ending in 1929. It should also be noted that in 1939 the Roanoke River Region with 21 per cent of the population of Virginia had 31 per cent of the wage earners. These workers drew 27 per cent of the wages but only produced 18 per cent of the output in the State. From Figure 2 of the same chart a similar parallel trend is observed in comparing the Roanoke River Region and Virginia with the Southeastern Region.

Table IV shows for the Roanoke River Region the distribution of workers in industry and the value of the output of each industry. The percentage of workers, the percentage of wages paid, and the percentage of output for major types of industry in the Roanoke River Region are plotted on Chart III.

Chart III brings out strikingly the predominant position of the textile industries in the industrial picture of the Roanoke River Region. Wood and wood industries and tobacco and tobacco products are next in importance but lag far behind textile production.

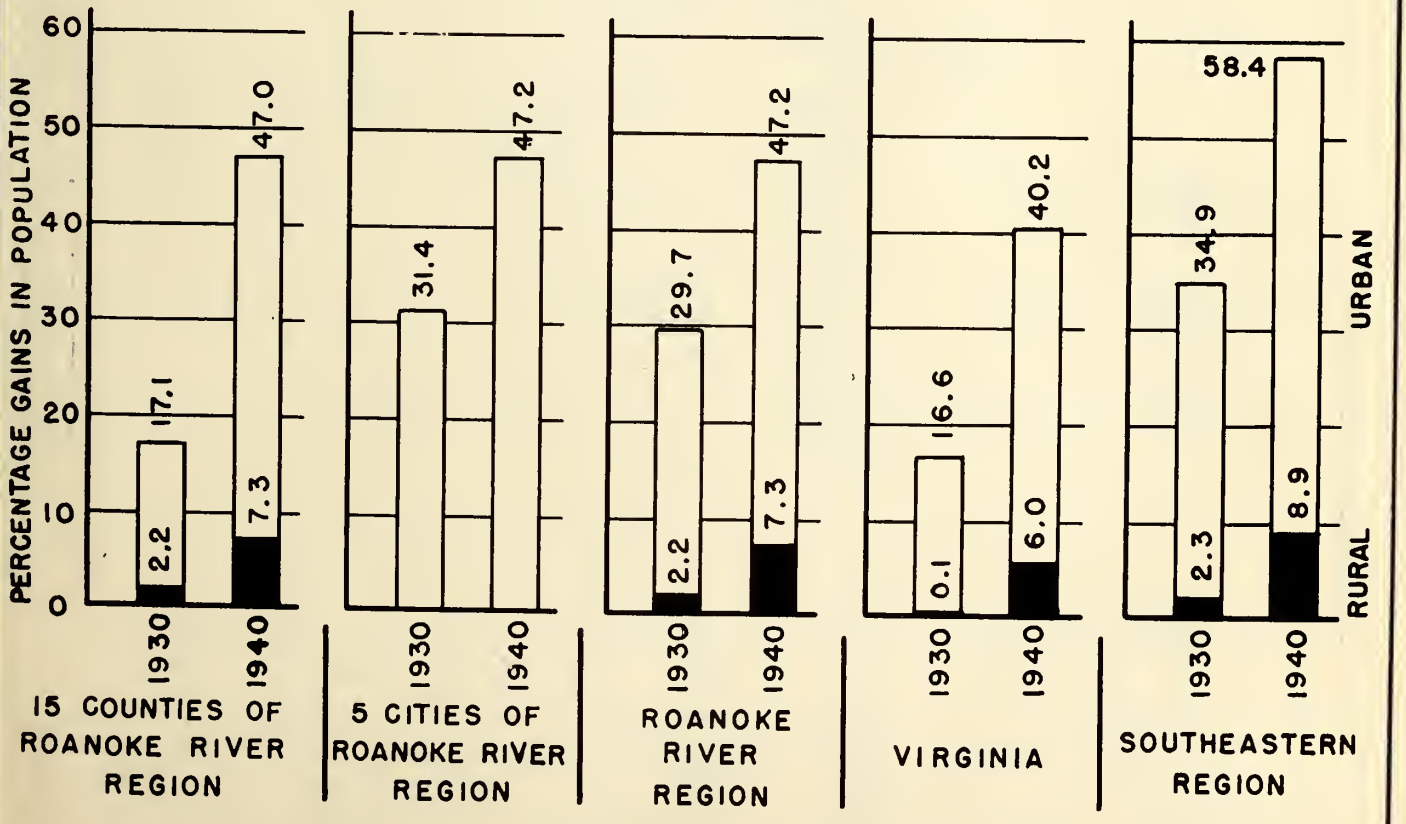
PERCENTAGE GAINS IN TOTAL POPULATION 1920 TO 1943

FIGURE 1



PERCENTAGE GAINS IN URBAN AND RURAL POPULATION 1920 TO 1940

FIGURE 2

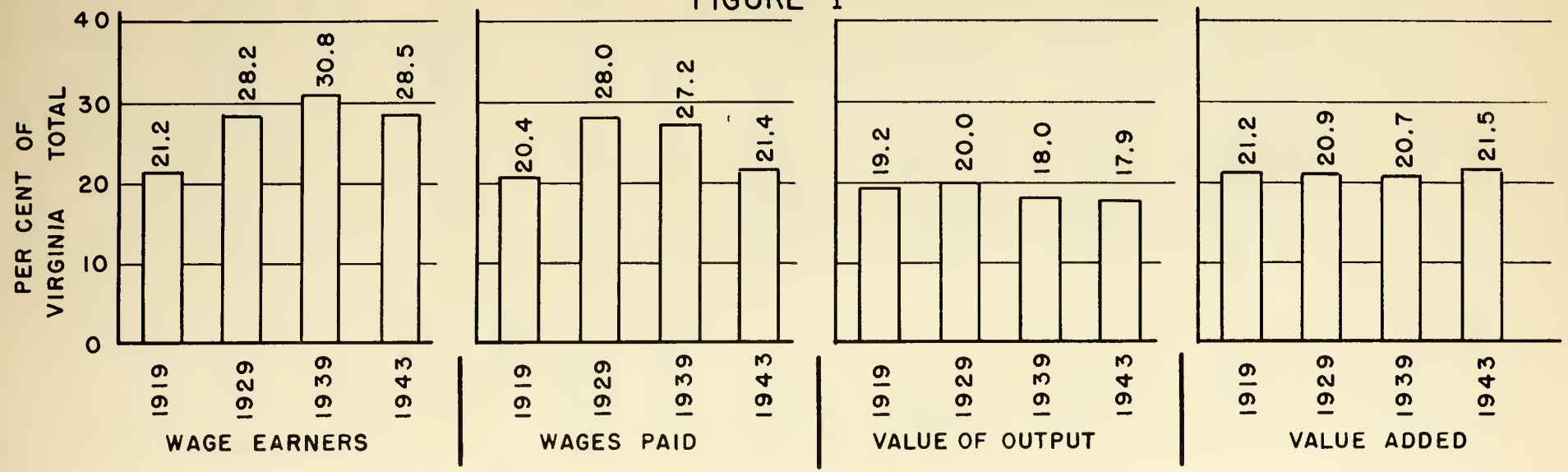


SOURCE:– 1920, 1935, 1940 CENSUS OF THE UNITED STATES.
1943 COUNTY BASIC DATA PUBLISHED BY MARKET RESEARCH DEPT. FARM JOURNAL INC., PHILADELPHIA, PA.

NOTE:– 1920 DATA TAKEN AS BASE INDEX

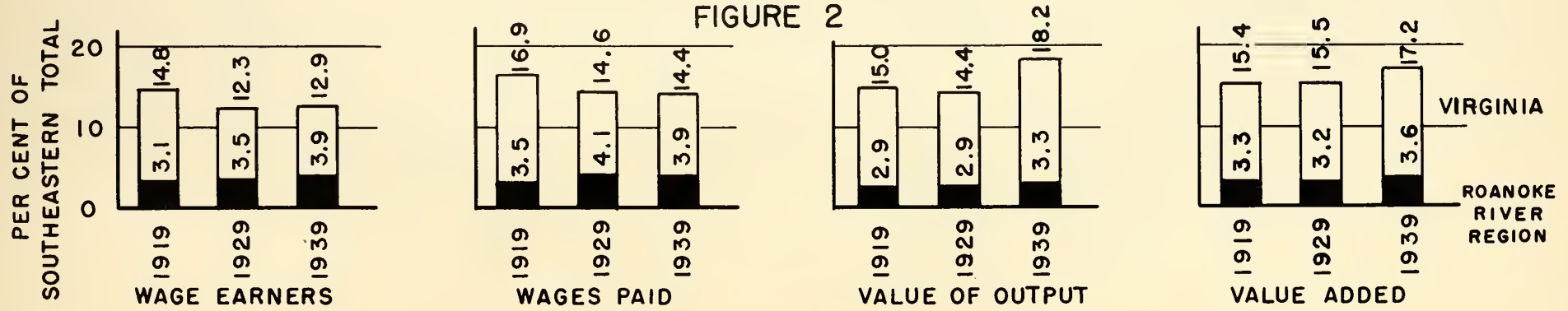
COMPARISON OF MANUFACTURES
ROANOKE RIVER REGION WITH VIRGINIA

FIGURE 1



COMPARISON OF MANUFACTURES
ROANOKE RIVER REGION AND VIRGINIA WITH SOUTHEASTERN REGION

FIGURE 2



SOURCE:– 1919, 1929, 1939 - U. S. CENSUS OF MANUFACTURES
1943 - VA. STATE DEPT. OF LABOR AND INDUSTRY

CHART II

TABLE III - MANUFACTURING STATISTICS

	Roanoke River Region	Virginia	Southeastern Region
1919			
Wage Earners (Number)	25,258	119,352	809,128
Total Wages (Thousands)	$24,487	$120,006	$709,143
Value of Output (Thousands)	$123,891	$643,512	$4,304,401
Value Added (Thousands)	$57,821	$271,971	$1,759,653
1929			
Wage Earners (Number)	33,928	120,273	975,520
Total Wages (Thousands)	$33,105	$118,089	$811,348
Value of Output (Thousands)	$149,171	$745,910	$5,180,624
Value Added (Thousands)	$79,451	$380,086	$2,451,526
1939			
Wage Earners (Number)	41,250	133,894	1,046,715
Total Wages (Thousands)	$31,495	$115,539	$800,547
Value of Output (Thousands)	$178,397	$988,813	$5,443,784
Value Added (Thousands)	$78,565	$379,488	$2,207,191
1943			
Wage Earners (Number)	55,452	194,266	--
Total Wages (Thousands)	$60,679	$283,583	--
Value of Output (Thousands)	$366,828	$2,044,344	--
Value Added (Thousands)	$155,269	$721,766	--

Source: 1919, 1929, 1939, U. S. Census of Manufactures
1943 Virginia State Department of Labor and Industry

During 1940, according to the Census of Population, the population employed in manufacturing was as follows:

	Total No. Employed	No. Employed in Manufacturing	Per Cent of All Employed Workers
Roanoke River Region	193,081	47,541	24.6
15 Counties	126,419	26,680	21.1
5 Cities	66,662	20,861	31.3
Virginia	933,058	187,681	20.1
Southeastern Region	7,320,813	1,364,776	18.6

FOREST LAND - Data from U. S. Department of Agriculture indicate that in 1940 the forest area was 56.4 per cent of the Roanoke River Region, which was divided as follows:

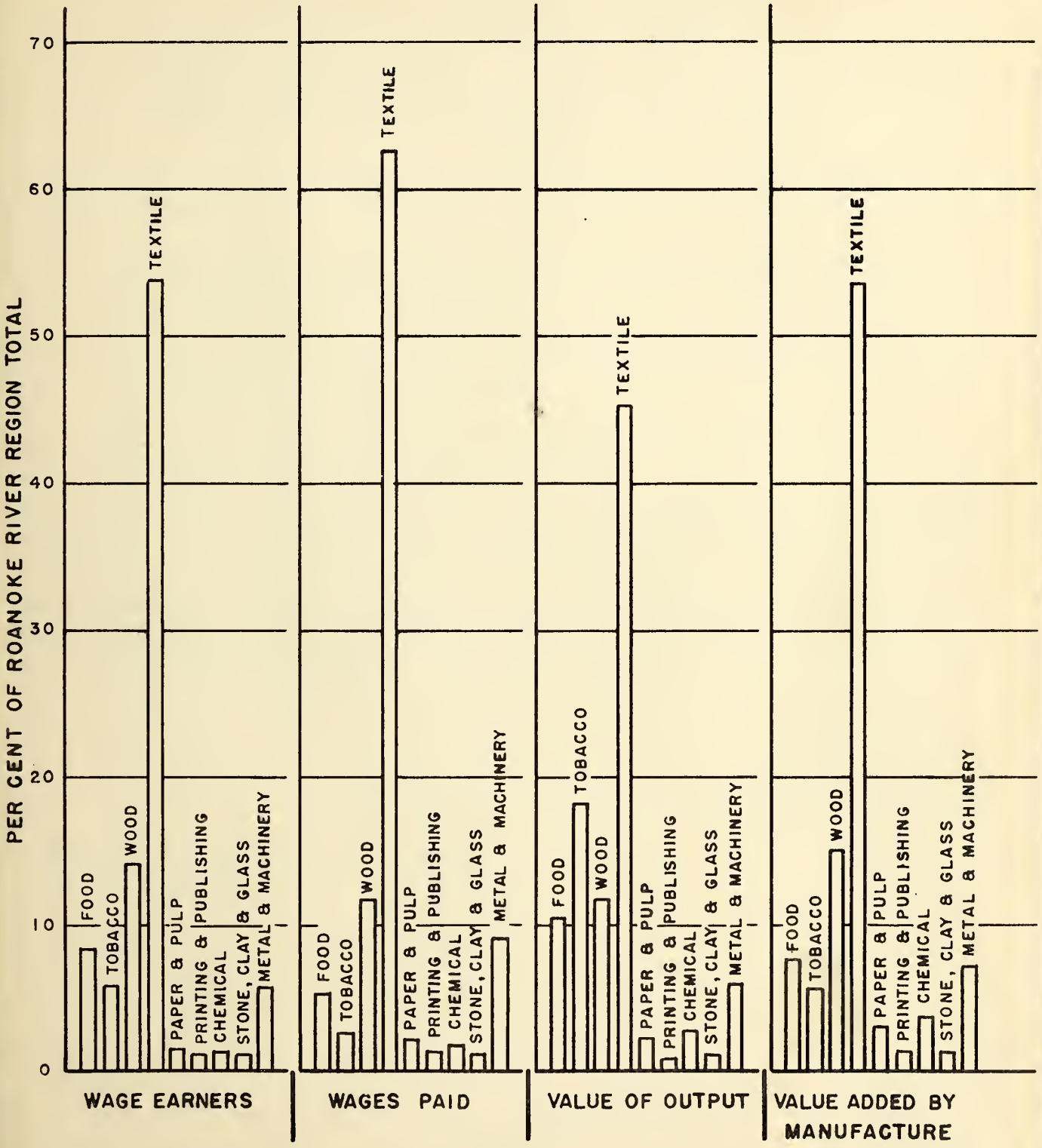
TABLE IV - DISTRIBUTION OF WORKERS, WAGES, AND VALUE OF MANUFACTURING ACCORDING TO TYPE, 1943

ROANOKE RIVER REGION

TYPE OF MANUFACTURING	WAGE EARNERS			WAGES (thousand dollars)			VALUE OF OUTPUT (thousand dollars)			VALUE ADDED BY MANUFACTURE (thousand dollars)		
	Region	Counties	Cities	Region	Counties	Cities	Region	Counties	Cities	Region	Counties	Cities
ALL MANUFACTURING	55,452	15,899	39,553	$60,679*	$14,297	$46,382*	$366,828*	$106,759	$260,069*	$155,269*	$43,776	$111,493*
Food	4,643	2,611	2,032	3,231	772	2,459	38,176	13,229	24,947	12,091	2,419	9,672
Tobacco	3,244	536	2,708	1,664	198	1,467	66,705	11,924	54,781	8,638	513	8,125
Wood	7,960	5,162	2,798	7,129	4,228	2,901	43,272	29,633	13,639	23,173	16,826	6,347
Textile	29,914	6,085	23,829	38,157	7,013	31,144	166,378	38,317	128,061	83,440	17,015	66,425
Paper and pulp	934	193	741	1,333	376	956	8,861	2,875	5,986	4,787	1,591	3,195
Printing and publishing	743	131	612	862	190	672	3,252	741	2,510	2,184	440	1,745
Chemical	842	151	691	1,079	211	868	9,922	2,462	7,461	5,714	2,346	3,368
Leather	2,634	86	2,548	280*	144	136*	1,179*	447	732*	609*	259	351*
Stone, clay and glass	707	418	289	707	383	324	4,160	2,080	2,080	1,783	910	873
Metal and machinery	3,158	208	2,950	5,609	478	5,131	21,956	3,854	18,102	11,016	705	10,311
Transportation equipment	141	8	133	142	5	137	763	62	701	576	51	525
Miscellaneous	532	310	222	485	299	186	2,205	1,136	1,069	1,259	702	557
PERCENTAGE	100.0	100.0	100.0	100.00	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Food	8.4	16.4	5.1	5.3	5.4	5.3	10.4	12.4	9.6	7.8	5.5	8.7
Tobacco	5.8	3.4	6.8	2.7	1.4	3.2	18.2	11.2	21.1	5.6	1.2	7.3
Wood	14.4	32.5	7.1	11.7	29.6	6.3	11.8	27.7	5.2	14.9	38.4	5.7
Textile	53.9	38.3	60.2	62.9	49.0	67.1	45.4	35.9	49.2	53.7	38.9	59.5
Paper and pulp	1.7	1.2	1.9	2.2	2.6	2.1	2.4	2.7	2.3	3.1	3.6	2.9
Printing and publishing	1.3	0.8	1.5	1.4	1.3	1.4	0.9	0.7	1.0	1.4	1.0	1.6
Chemical	1.5	0.9	1.7	1.8	1.5	1.9	2.7	2.3	2.9	3.7	5.4	3.0
Leather	4.7	0.5	6.4	0.5	1.0	0.3	0.3	0.4	0.3	0.4	0.6	0.3
Stone, clay and glass	1.3	2.6	0.7	1.2	2.7	0.7	1.1	1.9	0.8	1.1	2.1	0.8
Metal and machinery	5.7	1.3	7.5	9.2	3.3	11.1	6.0	3.6	7.0	7.1	1.6	9.2
Transportation equipment	0.2	0.0	0.3	0.2	0.0	0.3	0.2	0.1	0.3	0.4	0.1	0.5
Miscellaneous	1.0	1.9	0.6	0.8	2.1	0.4	0.6	1.1	0.4	0.8	1.6	0.5

* Incomplete figure

Source: Virginia State Department of Labor and Industry



DISTRIBUTION OF WORKERS, WAGES PAID AND VALUES BETWEEN MANUFACTURES ROANOKE RIVER REGION - 1943

SOURCE - VA. STATE DEPT. OF LABOR AND INDUSTRY

Type	Area (Acres)	Per Cent of Total Area
Public Reserved	6,200	0.1
Non-commercial	13,700	0.3
Commercial	3,020,100	56.0
Total	3,040,000	56.4

The U. S. Department of Agriculture defines these types of forest as follows:

Public reserved forest land consists of national parks, state parks, national monuments, and similar public areas on which commercial timber cutting is prohibited.

Commercial forest land includes both private and public lands, excluding public reserved lands.

Non-commercial forest land lacks the qualities essential for the of merchantable saw timber or pulpwood.

The forest area was estimated by the Corps of Engineers to be divided into 7 per cent old growth, 46 per cent second growth in saw log sizes and 47 per cent second growth under saw log sizes. The consumption of existing growth is at present somewhat greater than the potential forest growth. In 1941 the Census of Forest Products estimated the lumber production for the Roanoke River Region as 202,105,000 board feet, which was 19.6 per cent of Virginia's production. Virginia produced 11.6 per cent of the Southeastern Region production.

AGRICULTURE - Employment in agriculture for 1940 is tabulated below:

	Total No. Employed	Agricultural Workers	Per Cent of All Employed Workers
Roanoke River Region	193,081	60,201	31.2
15 Counties	126,419	59,525	47.1
5 Cities	66,662	676	1.0
Virginia	933,058	222,701	23.9
Southeastern Region	7,320,813	2,659,498	36.3

The total value of all farm products produced in 1929 and 1939 was as follows:

	Value in Dollars		Per Cent Decrease
	1929	1939	
Roanoke River Region	43,480,663	34,115,865	21
Virginia	204,653,013	150,912,239	26
Southeastern Region	1,799,382,806	1,299,720,467	28

The principal cash crops are tobacco, cotton, and peanuts, which are all classified as field crops.

The amounts and percentages of land in cultivation for the Roanoke River Region, as given in the last two reports of the Census of Agriculture, are as follows:

	1940	1945
Area in cultivation, acres	870,384	830,817
Percentage of total land area	16.2	15.5
Percentage of farm area	21.0	20.8

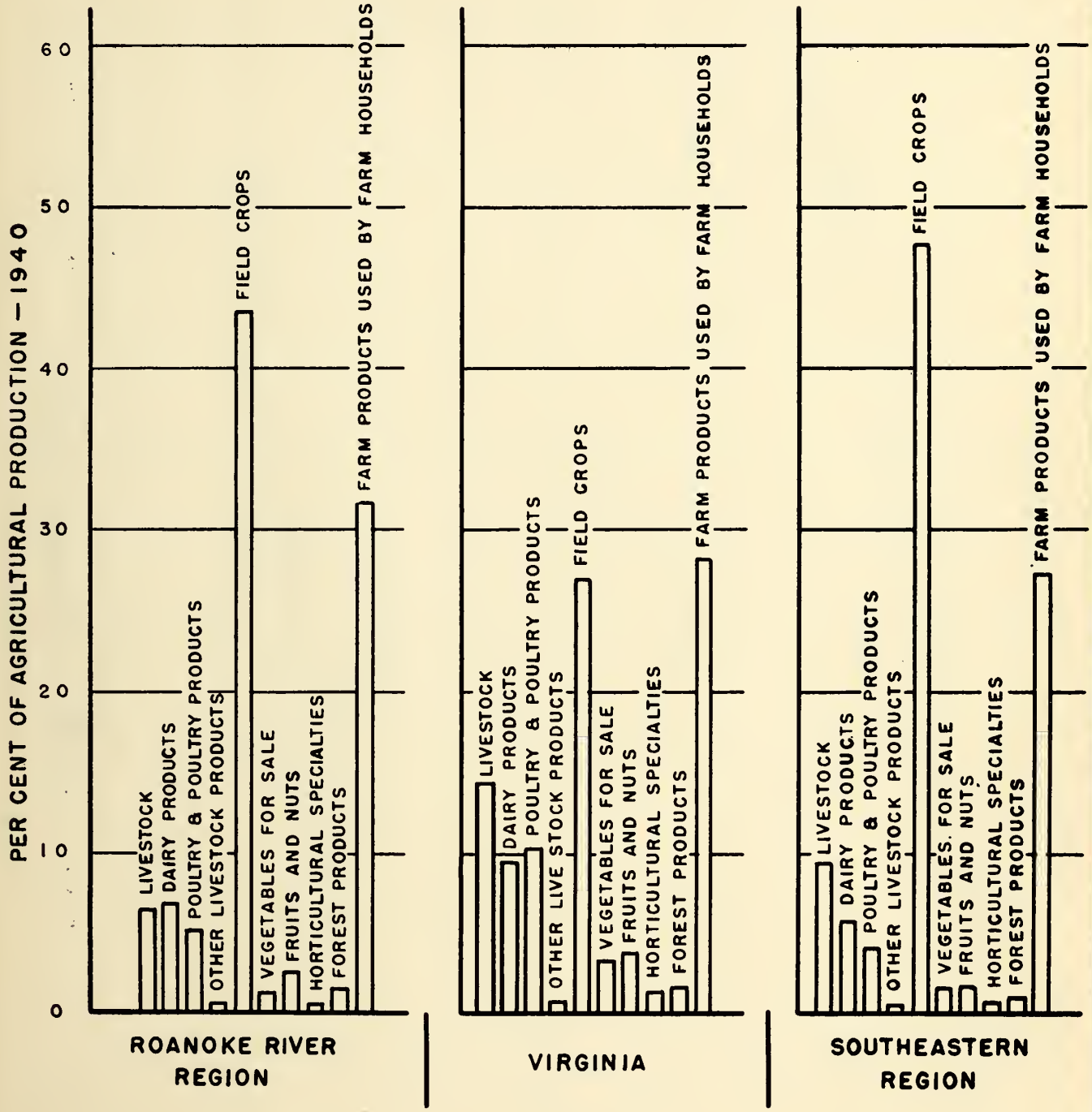
The values of the various crops produced are given in Table V and the percentages of total farm production are shown on Chart IV. This chart shows that the Roanoke River Region more nearly parallels the Southeastern Region than it does Virginia in the percentage production of standard types of farm products. Virginia seems to have a better balance between these various types of farm products than either of the two regions. This is perhaps to be expected having in mind the emphasis on tobacco in the Roanoke River Region and on cotton and tobacco in the Southeastern Region.

TABLE V - VALUE OF FARM PRODUCTS BY SOURCE OF INCOME - 1939

	Roanoke River Region		Virginia		Southeastern Region	
	Value	Per Cent	Value	Per Cent	Value	Per Cent
All Farm Products	$34,115,865	100.0	$150,912,239	100.0	$1,299,720,467	100.0
Livestock	2,202,103	6.4	21,592,755	14.3	122,799,518	9.4
Dairy Products	2,290,120	6.7	14,187,211	9.4	75,566,675	5.8
Poultry & Poultry Products	1,726,054	5.1	15,519,327	10.3	53,803,755	4.1
Other Livestock Products	192,280	0.6	1,289,874	0.8	5,884,905	0.5
Field Crops	14,892,093	43.6	40,696,858	27.0	621,789,002	47.8
Vegetables for Sale	433,328	1.3	4,820,237	3.2	21,009,750	1.6
Fruits and Nuts	846,411	2.5	5,779,724	3.8	22,362,763	1.7
Horticultural Specialties	195,523	0.6	2,104,818	1.4	8,528,738	0.7
Forest Products	523,766	1.5	2,383,357	1.6	13,352,221	1.0
Farm Products Used by Farm Households	10,814,187	31.7	42,538,078	28.2	354,623,140	27.3

Source: U. S. Census of Agriculture, 1940.

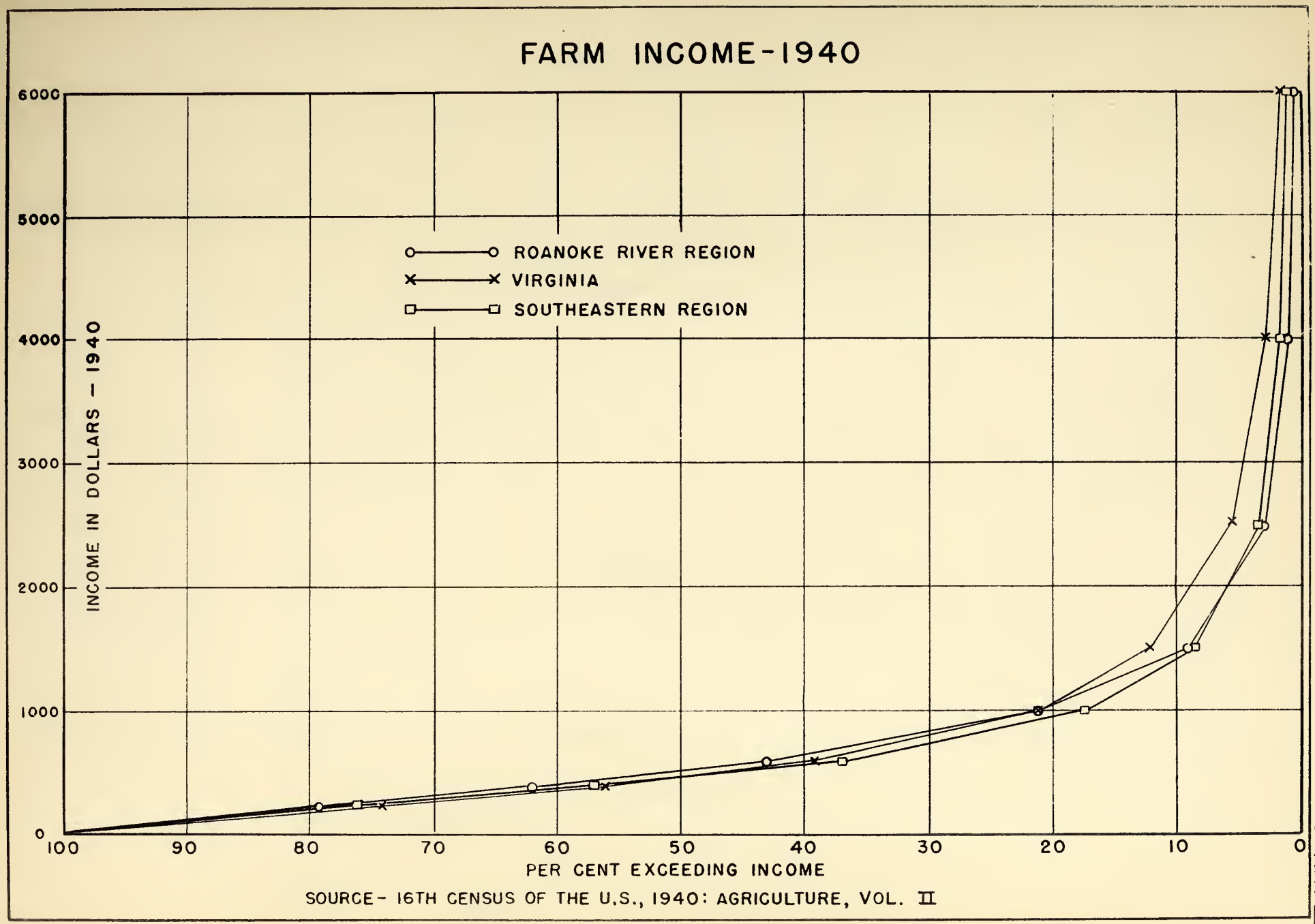
Chart V shows the range of farm income against percentage of farms and Chart VI, the range of size of farms. These charts show a remarkable similarity between the Roanoke River Region, the State of Virginia, and the Southeastern Region.



AGRICULTURAL PRODUCTION BY TYPES OF FARM PRODUCTS 1940

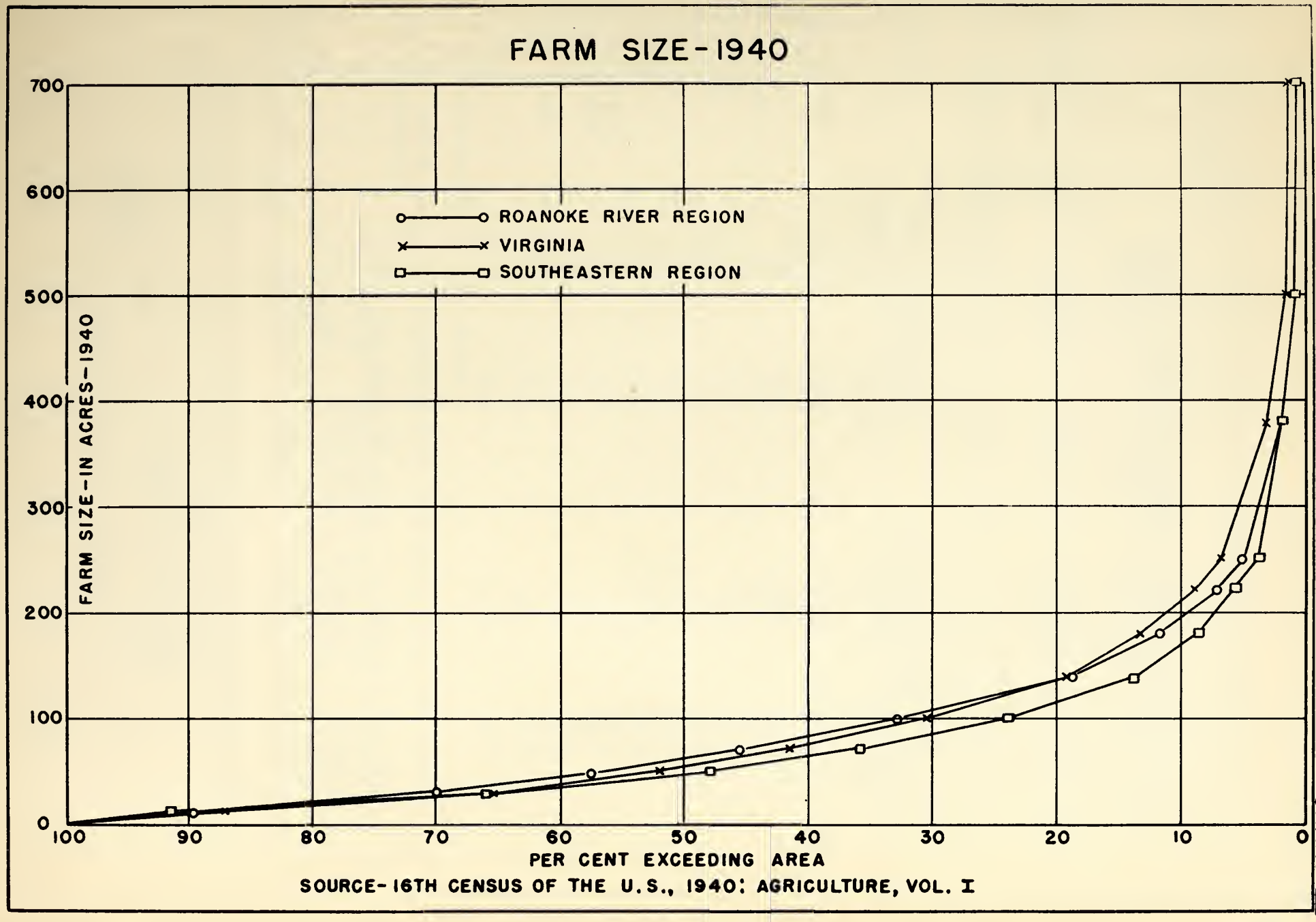
SOURCE — 16TH CENSUS OF THE UNITED STATES, 1940

FARM INCOME-1940



SOURCE- 16TH CENSUS OF THE U.S., 1940: AGRICULTURE, VOL. II

CHART-V


FARM SIZE - 1940
ROANOKE RIVER REGION
VIRGINIA
SOUTHEASTERN REGION
FARM SIZE - IN ACRES - 1940
0
100
200
300
400
500
600
700
100
90
80
70
60
50
40
30
20
10
0
PER CENT EXCEEDING AREA
SOURCE - 16TH CENSUS OF THE U.S., 1940: AGRICULTURE, VOL. I
CHART - XI

The United States Census of Housing gives the following data on rural dwellings having electric lighting in 1940:

	Rural Non-Farm Dwellings		Rural Farm Dwellings	
	Number with Electricity	Per Cent of Dwellings	Number with Electricity	Per Cent of Dwellings
Roanoke River Region	20,238	67.8	10,169	18.5
Virginia	117,858	64.6	51,981	23.7
Southeastern Region	789,209	59.9	370,451	16.2

The 1939 United States Census of Agriculture gives the following data on farms for each county:

COUNTY	FARM DWELLINGS LIGHTED BY ELECTRICITY		FARM DWELLINGS WITHIN ONE-QUARTER MILE OF DISTRIBUTION LINE	
	Number	Per Cent	Number	Per Cent
Appomattox	316	23.9	330	25.0
Bedford	1,008	24.6	1,959	47.7
Botetourt	734	43.2	1,086	63.9
Brunswick	500	19.7	1,009	39.8
Campbell	718	27.1	1,276	48.2
Charlotte	302	12.4	983	40.4
Floyd	335	14.7	441	19.3
Franklin	617	16.0	1,043	27.0
Halifax	411	7.0	1,427	24.2
Henry	558	25.0	839	37.6
Mecklenburg	535	12.4	1,864	43.3
Montgomery	610	36.5	881	52.7
Patrick	310	10.3	829	27.6
Pittsylvania	1,065	15.4	2,564	37.0
Roanoke	950	62.1	1,137	74.3
Total	8,969	19.3	17,668	38.0

Total Number of Farms - 46,446

The 1940 U. S. Census of Housing gives data on dwellings with running water as follows:

	Rural Non-Farm Dwellings		Rural Farm Dwellings	
	Number of Dwellings	Per Cent of Dwellings	Number of Dwellings	Per Cent of Dwellings
Roanoke River Region	12,001	40.1	4,574	8.3
Virginia	75,278	41.1	27,112	12.3
Southeastern Region	481,482	36.5	127,801	5.6

The reports of the U. S. Census give the percentage of farms operated by tenants as follows:

	Percentage of Tenancy		
	1930	1935	1940
Roanoke River Region	40.1	40.6	39.0
Virginia	28.1	29.5	26.9
Southeastern Region	54.9	53.2	48.6

The percentage of tenancy varied widely among the counties of the Roanoke River Region. The individual county percentages for this region are given below.

County	Percentage of Tenancy		
	1930	1935	1940
Appomattox	36.6	38.6	37.7
Bedford	24.6	34.2	25.8
Botetourt	12.3	16.6	17.0
Brunswick	41.9	34.8	37.3
Campbell	36.5	39.5	30.4
Charlotte	43.7	50.1	47.0
Floyd	11.1	15.6	14.0
Franklin	28.9	28.1	28.8
Halifax	58.3	59.2	59.6
Henry	36.3	33.8	28.1
Mecklenburg	55.1	53.0	54.3
Montgomery	16.6	24.9	18.9
Patrick	30.9	31.9	29.3
Pittsylvania	59.7	58.1	58.2
Roanoke	15.5	16.7	15.0

Some notable facts indicative of the situation in the Roanoke River Region are conveyed by the foregoing tables, pages 45 to 54 inclusive, and might be worthy of repetition.

In 1940 the percentage of employed workers engaged in agriculture in the Roanoke River Region was more than that for Virginia as a whole, and somewhat less than for the Southeastern Region which includes some predominately agricultural states. These statistics show that the percentage of rural farm dwellings in the Roanoke River Region having electricity and running water is less than for Virginia but somewhat greater than for the Southeastern Region. Farm tenancy in the Roanoke River Region was considerably higher than in the State as a whole, but the percentage was less than that for the Southeastern Region.

TRANSPORTATION FACILITIES - The basin is adequately served by railroads. These are shown on Plate III, the principal ones being the Southern, the Norfolk and Western, the Virginian, the Atlantic Coast Line, and the Seaboard. Primary highways are also shown on Plate III, and these are adequately supplemented by secondary roads. Eastern Airlines and American Airlines cross the basin and have scheduled stops at Roanoke, Virginia. When traffic conditions warrant, additional stops can be inaugurated. Delta Airlines crosses the lower end and passes close to the southern edge of the basin. The Roanoke River has a navigable channel of eight feet or greater from the mouth to Palmyra, N. C.

WATER RESOURCES - Existing reservoirs in the Roanoke River Basin as taken from the Review Report of the Corps of Engineers are listed in Table VI. The total installed capacity of hydroelectric plants in the basin is estimated as 33,200 kilowatts. One small recreational lake has been formed by the construction of an earth dam on Goblintown Creek, a tributary to the

TABLE VI - EXISTING RESERVOIRS IN THE ROANOKE RIVER BASIN

LOCATION OF RESERVOIR	STREAM	MILES ABOVE MOUTH OF STREAM	OWNER	AREA OF SURFACE, ACRES	DRAINAGE AREA SQ. MI.	STORAGE CAPACITY ACRE-FT.	PRINCIPAL USE OF STORAGE	POWER INSTALLATION KW
Roanoke, Va	Roanoke	360.58	Appalachian Electric Power Company	Small	388	Small	Condensing Water	(B)
Roanoke, Va.	Roanoke	359.24	American Viscose Corporation	Small	389	Small	Process Water	(B)
Roanoke, Va.	Roanoke	359.18	American Viscose Corporation	Small	389	Small	Process Water	(B)
Niagara, Va.	Roanoke	355.30	Appalachian Electric Power Company	70	511	Small	Water Power	2,900
Roanoke Rapids, N. C.	Roanoke	137.52	Virginia Electric and Power Co.	45	8,395	Small	Water Power	6,200
Patrick County, Va.	Dan	195.38	City of Danville, Va.	165	20	7,590	Water Storage	(B)
Patrick County, Va.	Dan	190.18	City of Danville, Va.	40	33	1,150	Water Power	10,000
Walnut Cove, N. C.	Dan	131.30	Duke Power Company	10	397	Small	Water Power	600
Schoolfield, Va.	Dan	65.91	Riverside & Dan River Cotton Mills	600	1,878	1,500	Water Power	5,500
Danville, Va.	Dan	63.70	Riverside & Dan River Cotton Mills	300	2,049	Small	Water Power)	
Danville, Va.	Dan	63.28	Riverside & Dan River Cotton Mills	Small	2,049	Small	Water Power)	3,500
Mayodan, N. C.	Mayo	2.20	Washington Mills	Small	(A)	Small	Water Power	(A)
Mayodan, N. C.	Mayo	3.70	Washington Mills	Small	(A)	Small	Water Power	(A)
Fairystone State Park, Va.	Smith	53.00	State of Virginia	141	21	Small	Recreation	(B)
Martinsville, Va.	Smith	24.70	City of Martinsville, Virginia	200	374	1,200	Water Power	1,300
Spray, N. C.	Smith	2.70	Spray Water, Power & Land Company	20	545	Small	Water Power	1,100
Halifax, Va.	Banister	11.30	Virginia Electric and Power Co.	380	520	Small	Water Power	1,300
Rocky Mount, Va.	Pigg	49.00	Appalachian Electric Power Company	Small	(A)	Small	Water Power	150

(A) Data Not Available.
(B) Not applicable.

Source: Review Report on Roanoke River, U. S. Corps of Engineers, dated January 30, 1943.

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Smith River, which flows through the Fairystone State Park. Other small reservoirs are used for the storage of condensing water for steam plants, processing water for industrial plants and for operating grist mills. Storage capacities are given in Table VI and are so small that the combined effect on the flood flows on the Roanoke River is negligible. There are no flood control reservoirs in the basin.

The Division of Water Resources and Power of the Virginia State Commission of Conservation and Development has investigated the chemical characteristics of the surface waters of the Roanoke River Basin and the results are published in Bulletin No. 3 of that Commission. The water of the Roanoke River at Roanoke, Virginia is moderately hard, averaging 137 parts per million (Calcium Carbonate Scale). This hardness decreases to 41 parts per million at Randolph, Virginia, due to the inflow of tributaries originating east of the Blue Ridge. Some of the tributaries along the reach from Roanoke to Randolph, Virginia, supply soft water whose average hardness is as follows:

Stream	Average Hardness Parts Per Million
Blackwater River	18
Pigg River	22
Goose Creek	55
Otter River	25
Falling River	22

The Smith River water as sampled at Martinsville, Virginia, is siliceous in type, and soft; the total dissolved solids average 50 parts per million and the hardness is 24 parts per million. The Dan River water as sampled at South Boston, Virginia, is very similar to the Smith River water; the dissolved solids and the hardness average 58 and 22 parts per million respectively. The tributaries of the Dan River are very similar to the main stream and like it usually appear highly colored due to the relatively large amount of suspended material. The quality of the water of the Roanoke River, below its confluence with the Dan River, is largely influenced by the latter stream. One sample taken at Old Gaston, N. C., showed a hardness of 40 parts per million. The data given above are the results of observations carried on in 1929-30 by the Division of Water Resources with check samples in 1930-31.

The major points of industrial pollution of the Roanoke River Basin in Virginia as determined by a joint survey by the State Planning Board, the Commission of Game and Inland Fisheries, and the Health Department are:

Bedford	Martinsville	Bassett
Roanoke	Fieldale	Stuart
Salem	Stanleytown	South Boston
Schoolfield		

It is estimated that the urban population of the basin served by sewage treatment plants is as follows:

	Persons
Complete treatment	5,000
Primary treatment and chlorination	1,500
Primary treatment	4,200

The sewage from the remainder of the urban population served by sewers is discharged untreated into the Roanoke River or a tributary thereof.

Surface water supplies are now generally adequate for municipal and industrial use along the Roanoke River and its tributaries in Virginia and the development of Buggs Island, Gaston, and Roanoke Rapids Projects will not materially affect them. The other reservoirs will add to these supplies in Virginia. Philpott No. 4 will maintain a minimum flow of 32 cubic feet per second at Bassett, Va., during a critical drought period such as 1930-31 and will provide an average regulated flow throughout such a period of 218 cubic feet per second. Smith Mountain will have a similar effect in maintaining an average regulated flow of 842 cubic feet per second during the same critically dry period. The other projects, having smaller storage volumes, will have correspondingly smaller effects.

These increases in low water flow will greatly increase the reserve for municipal and industrial use. The decrease in velocity of flow through the reservoirs will also remove a large percentage of the silt load and result in a water that is usable with less treatment. This is especially important in the large Piedmont region where the streams are usually muddy. The increased flow will further dilute the untreated domestic and industrial wastes.

The weekly low flow of record at Martinsville, Virginia, occurred in September, 1932 when the discharge was 65 cubic feet per second. Regulation by Philpott No. 4 will maintain an average weekly flow of at least 200 cubic feet per second. This would greatly alleviate the stream pollution from domestic and industrial wastes now discharged into the stream.

SILTING OF RESERVOIRS - The Roanoke River carries considerable quantities of silt. The Corps of Engineers, from data collected by the U. S. Department of Agriculture, has estimated a silting rate of 50 acre-feet per 100 square miles of drainage area per year. The same authority also estimates that one-third of this silt will be deposited in the upper end of the reservoirs and the remainder in dead storage. The following is a tabulation of the percentages of loss of storage based on the above rate:

Reservoir	Percent Loss of Storage in 50 Years	
	Usable Power Storage	Total Power Storage
Buggs Island		
(If only project constructed)	4	12
(As unit in complete plan)	2	5
Philpott No. 4	2	2
Gaston	*	3
Roanoke Rapids	*	3
Smith Mountain	2	3
Leesville	*	16
Taber	*	56
Melrose	*	4
Randolph	3	5
Stuart	3	5
Schoolfield	12	16

*These plants have very small storage and silting will influence power producing capacity very little. More than two-thirds of the silt will be deposited in dead storage.

Computation from data contained in publications of the United States Department of Agriculture, Soil Conservation Service, are in substantial agreement with the estimates made by the Corps of Engineers.

RECREATIONAL AREAS - The Roanoke River Basin now has a very small percentage of area in public ownership, and except for about 7,000 acres in North Carolina the publicly owned land is largely forest. In the basin there are two Virginia State parks, Staunton River and Fairystone. These parks now offer swimming and camping facilities with the other usual outdoor recreational activities. The Blue Ridge Parkway crosses the basin near Roanoke, Virginia. There are small areas of national forests. Several waysides are maintained by the State Highway Department.

EFFECT OF BUGGS ISLAND AND PHILPOTT NO. 4 PROJECTS ON RECREATION - The National Park Service has made a report on the recreational resources of Buggs Island and Philpott Reservoirs. Neither reservoir will have a lasting effect upon tourist travel through Virginia although sightseeing travel to the dams may increase for some time to come. The reservoirs would have considerable vacation and day use if needed facilities are provided. Likewise there are opportunities for organized camping either by groups or as often sponsored by the Boy Scouts, Y. M. C. A.'s, etc. Both reservoirs have areas adjacent to the pool satisfactory for the construction of private cabins. This is especially true of Philpott, which is located in the summer-cool, mountain vacation belt.

The attractiveness of Buggs Island will probably not equal that of Philpott. From experience with similar lakes, notably Lake Murray located near Columbia, S. C., it is quite possible that the water in Buggs Island will be turbid. Philpott will perhaps be relatively clear and attractive. The levels of both pools will have a large seasonal fluctuation; in the average year at Buggs Island, the drawdown from the maximum power pool elevation at 300 will be approximately as follows:

Date	Distance below Elevation 300	Date	Distance below Elevation 300
May 1	2.0 ft.	November 1	14.0 ft.
June 1	1.0 ft.	December 1	20.0 ft.
July 1	0.0 ft.	January 1	20.0 ft.
August 1	2.0 ft.	February 1	20.0 ft.
September 1	5.0 ft.	March 1	10.0 ft.
October 1	9.0 ft.	April 1	7.0 ft.

This will detract from the recreational usefulness of the reservoir, particularly at Buggs Island where much of the shoreline has a relatively flat slope.

The National Park Service makes ten recommendations for recreational procedures at Philpott, which are substantially the same as for Buggs Island. These recommendations are that:

"(1) Philpott and other potential reservoirs in the Smith and Roanoke River basins be considered jointly so that no development be made at Philpott which would be better placed elsewhere.

(2) Early contact be made with the Virginia Conservation Commission to integrate recreational plans for Philpott Reservoir and Fairystone State Park, including the possibility of adding to the latter certain lands which must be purchased for development of the reservoir.

(3) Preparation of recreational master plan for the reservoir be in very simple form.

(4) The early form of this document be confined to a statement covering broad policies of development and operation, together with a single map zoning lands adjacent to the reservoir in general terms, for various types of use.

(5) The document be expanded, particularly in the way of more detailed drawings, as pending decisions, which will influence expectancy of use, are made.

(6) Free public access be maintained, at selected locations, for types of use requiring no formalized facilities.

(7) No formalized facilities for day-use be planned or installed, since Fairystone State Park appears adequate to care for anticipated requirements.

(8) Master plans take into consideration the advisability of permitting commercial furnishing of services and supplies to recreation-seekers, in suitable locations.

(9) Areas be set aside, in the master plan, for individual or group cabin sites, to be occupied under permit.

(10) Further field study, preceding preparation of the master plan, to be made by those in the District Office to whom the responsibility for such preparation will be delegated."

The Fish and Wildlife Service of the United States Department of the Interior has prepared a report on Buggs Island Reservoir and the data below are taken from this report, dated May, 1946.

Buggs Island is on a reach of the river where only rough fish such as carp and catfish are caught and while the fishing is not expected to be excellent the proposed development should improve the present poor conditions. Buggs Island will materially affect the deer and turkey hunting and it is doubtful if these species when driven from the river bottoms will be

able to survive. Bobwhites and foxes will not be as greatly affected but many will have to seek new ranges. The importance of other game is at present minor. Wild ducks should find conditions more favorable than at present for their migratory stops but due to the scarcity of food, their stay will be short.

Because of the relatively small area flooded, Philpott will have only a minor effect on the wildlife in the region.

It is possible the Buggs Island Reservoir could adversely affect the spawning grounds of the striped bass (rockfish) in the lower river near Weldon, N. C. These spawning grounds are the most important ones on the Atlantic Coast and striped bass is one of the most highly prized fish for food and sport on this coast and is an important commercial fish. Unless flows at Weldon are maintained sufficiently high to reduce pollution to a satisfactory level and maintain satisfactory water temperatures the effect on these spawning beds may be serious. The proposed operating schedule is believed to preclude any adverse effect on the spawning of striped bass.

The Fish and Wildlife Service summarizes its report as follows:

"1. Upland game and fur animals will suffer a total loss of habitat on 51,200 acres below the minimum pool elevation.

2. There will be at least a 50 per cent loss to all upland game and fur animal habitat between minimum pool and full pool elevations (36,700 acres.)

3. There will be a permanent loss in fishing of 32 miles of main stream, and 107 miles of tributary streams.

4. There will be at least a 50 per cent loss from periodic flooding to 14 miles of main stream, and 102 miles of tributary streams.

5. There will be a loss of 11,000 acres of waterfowl habitat.

6. There will be provided a minimum of 28,900 acres of water available as a nesting area for migratory waterfowl in November and December.

7. There will be a gain in fisheries value on 178 miles of stream resulting from benefits of pollution abatement and low water regulation.

8. There will be a gain of 28,900 acres of reservoir for fishing.

9. An extremely important fishery in the vicinity of Weldon, North Carolina, depends for its survival upon proper operation of the reservoir.

10. These losses and gains have been evaluated and the net gain from the project is $73,000 annually."

This Service draws the conclusion that: "The net effect of the project will be beneficial to fish and wildlife resources if the project is constructed

and operated as proposed by the sponsor. The net annual value of this benefit is estimated to be $73,000, which results from an annual gain of $100,000 in fishery resources as compared with an annual loss of $27,000 in wildlife resources. Additional values can be derived from the project if sub-impoundments are constructed where feasible to compensate the loss of wildlife habitat".

MALARIA CONTROL - At this time, no malaria problem exists in the area adjacent to the Buggs Island Reservoir. Conditions in the vicinity are favorable to propagation of the Anopheles mosquito but the spread of this mosquito can be effectively controlled. In the areas surrounding the lakes operated by the Tennessee Valley Authority, the Duke Power Company and the Carolina Power and Light Company, conditions for the spread of the Anopheles mosquito are likewise favorable but by proper operation of the reservoir, malaria has not menanced the health of nearby inhabitants.

The Virginia State Department of Health, the North Carolina State Board of Health, and the United States Public Health Service have prepared a report covering all aspects of malaria control. By following the recommendations of this report, danger from malaria will be eliminated.

The operating procedure for the reservoir, based on that report, will include the following:

1. The reservoir will be cleared completely of all trees and brush from elevation 303 to elevation 269. All trees extending above 269 will be removed or topped. Those trees growing on steep banks which might fall into the reservoir will be removed. All dead trees standing between elevations 303 and 320, will be removed each year.

2. During filling of the reservoir, all flotage will be collected and burned.

3. The pool will be drawn down gradually during the mosquito breeding season to strand the larvae and thus destroy them. The reservoir will be initially filled during the fall, winter, or spring months. Each spring if possible, the reservoir will be raised to about 303 and the water surface then dropped quickly in order to strand flotage and inhibit the growth of vegetation.

4. All small pools left by the drawdown of the reservoir will be drained.

5. The shore area will be treated with larvicides when the pool is raised during the breeding season.

6. The banks covered by the fluctuations of the power pool will be maintained free from growth and flotage.

The estimated cost of $100,000 for this work has been included in the annual charges to the development.

Incidence of malaria is small in the mountain sections of the basin, although some outbreaks have occurred. The steep slopes are conductive to good drainage and an absence of breeding pools. By applying the same methods of operation that will be used at Buggs Island, the control of malaria adjacent to the other reservoirs should be easily accomplished. Sufficient fluctuation of the power pool should be provided by the daily and weekly cycle of operation but if this should prove to be insufficient, an operating schedule that would provide the necessary fluctuations will be established.

HYDROLOGY

CLIMATE - Rigorous but not severe winters and warm summers are characteristic of the region except at higher elevations of the Blue Ridge and Alleghenies. Long and relatively cool springs may be expected in the eastern Piedmont. The autumn months are usually open and dry and in winter moderately heavy snowfalls occur in the western portions of the basin. Near the coast where the land is low and comparatively level local peculiarities of climate are almost entirely absent.

The average annual temperature is about 56 degrees, ranging from 54 degrees in the Appalachian Highlands to 59 degrees in the Tidewater Section. Maximum temperatures do not differ greatly in the different geographical divisions of the basin. An extreme of 107 degrees has been recorded at Danville, Virginia. The lowest winter temperatures, however, differ greatly. They are much lower in the higher mountain area than in Tidewater or the Piedmont.

PRECIPITATION - The precipitation in the basin is reasonably well distributed. The heaviest precipitation occurs in the southwest portion with the maximum occurring at Pinnacles of Dan in Patrick County, Virginia. The amount decreases in all directions from that point, the least occurring in the Piedmont area, which comprises the major portion of the watershed. The mean annual precipitation for the basin is approximately 43 inches, varying from 41 inches at Roanoke, Virginia, to 60 inches at Pinnacles of Dan, Virginia, and 49 inches at Williamston, N. C. The precipitation on the large area of the Piedmont is approximately the same as the average for the watershed. This average yearly rainfall for the period 1891 through 1941 is plotted on Chart VII.

Flood-producing storms occur in all seasons of the year. Table VII which follows shows the distribution by months of floods recorded at Weldon, N. C.

TABLE VII - MONTHLY DISTRIBUTION OF FLOODS
ROANOKE RIVER AT WELDON, N. C. - 1899 TO 1940
(Data from Review Report, Corps of Engineers, Table 10)

Month	Number of Floods Above Stage of 50 feet	45 feet	40 feet	35 feet	Total
January	0	2	7	19	28
February	0	0	3	11	14
March	1	2	10	19	32
April	0	0	2	13	15
May	0	1	2	5	8
June	0	0	1	4	5
July	0	1	2	3	6
August	1	2	5	11	19
September	0	0	1	5	6
October	0	3	5	7	15
November	0*	0	0	2	2
December	0	0	1	6	7
Total for Period	2	11	39	105	157

*Second largest known flood occurred in November 1877.

Widespread winter storms of sustained but not intense rainfall produce frequent general floods which are not usually of great magnitude. Summer storms, frequently associated with tropical hurricanes, produce brief, intense rainfall, usually on a small portion of the basin, and cause extreme local floods which diminish in importance away from the storm center. Either winter storms with unusual intensity or summer storms of a general nature are capable of producing extreme floods.

Flood-producing storms in the Roanoke River Basin may be of three general types.

1. Cold front storms, as those of August 18, 1939, and August 11, and 16, 1928.

2. Warm front storms, as that of October 19, 1937.

3. Local thunderstorms on small areas, as that of August 8, 1942, when 6.66 inches of rain fell in a few hours on the watershed of Otter River near Bedford, Virginia.

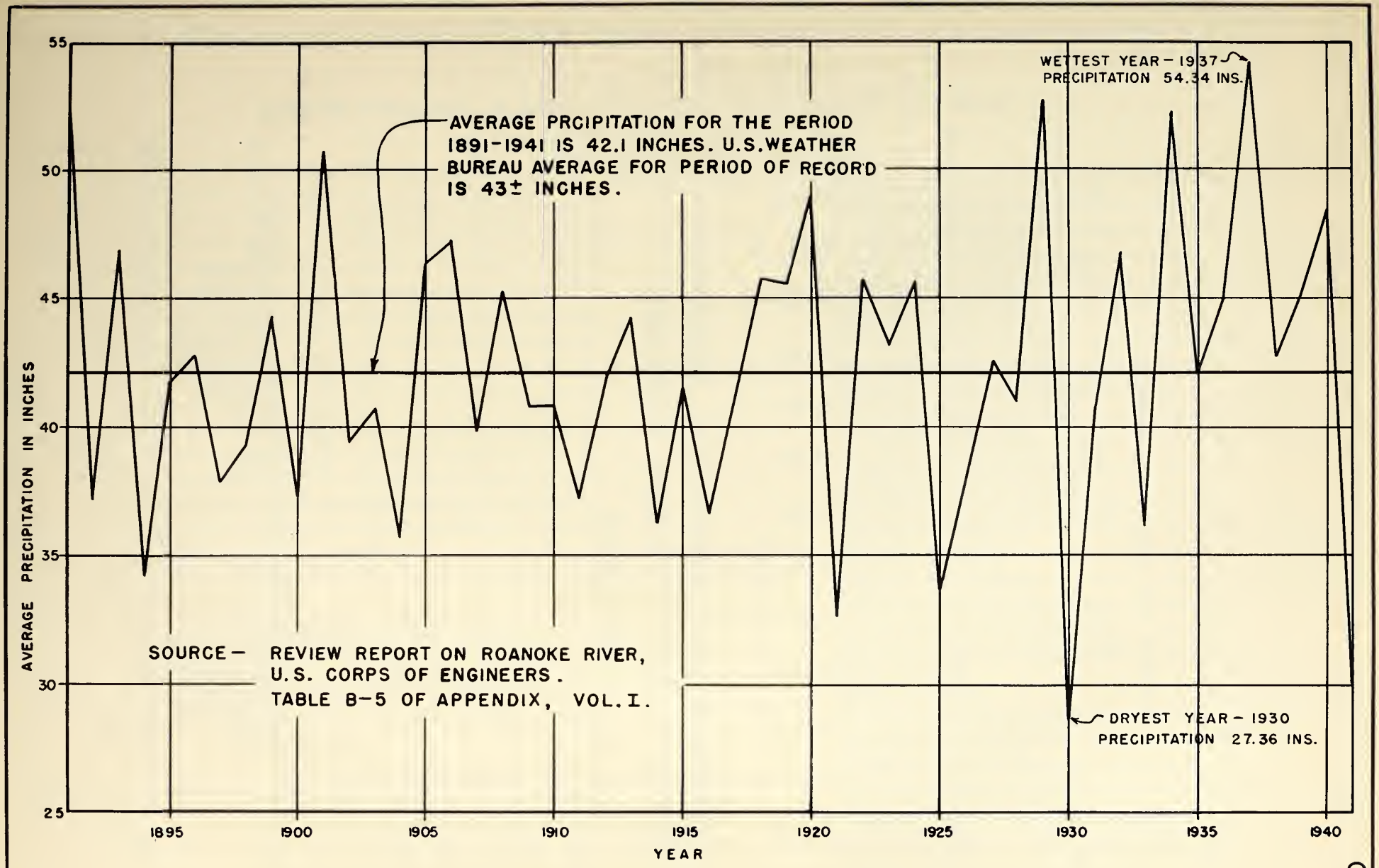
The unusual storm of August 10-17, 1940, included all three types during this eight day period. This flood was the most devastating of any to date and caused a loss in the basin in excess of $5,250,000.

RUNOFF - Data on runoff at several stations as taken from the Review Report of the Corps of Engineers are given below:

Period	Maximum Cubic Feet Per Second	Minimum Cubic Feet Per Second	Average Inches Per Year	Ratio: Runoff Rainfall (Per Cent)	Average Cfs. Per Sq. Mi. of Drainage Area
	Roanoke River near Roanoke Rapids, N. C.				
1912-40	261,000	472	13.85	32	1.02
	Smith River at Martinsville, Virginia				
1931-39	39,000	5	15.78	34	1.19
	Roanoke River near Roanoke, Virginia				
1896-40	28,000	0	--	--	1.03
	Dan River near South Boston, Virginia				
1923-40	81,000	208	--	--	1.08

The average annual discharge in cubic feet per second per square mile at Old Gaston, N. C., has been plotted on Chart VIII, Figure 1.

DROUGHT RECORDS - Two very severe droughts have occurred in the Roanoke River Basin, one during 1838-1840 and the other during 1930-1932. It is believed that the former was the more severe. Other droughts occurred in 1775, 1785, 1793, 1806, 1826-27, 1845, 1879, 1881, 1895, 1925-26, 1941. Monthly runoff at Old Gaston, N. C., for the severe drought of 1930-1932 is shown on Chart VIII, Figure 2. For thirty months beginning with April 1930, the runoff averaged 0.583 cubic feet per second per square mile. This is equivalent to a discharge of 4868 cubic feet per second at the gaging station or to a runoff of approximately 0.65 inches over the watershed each month.

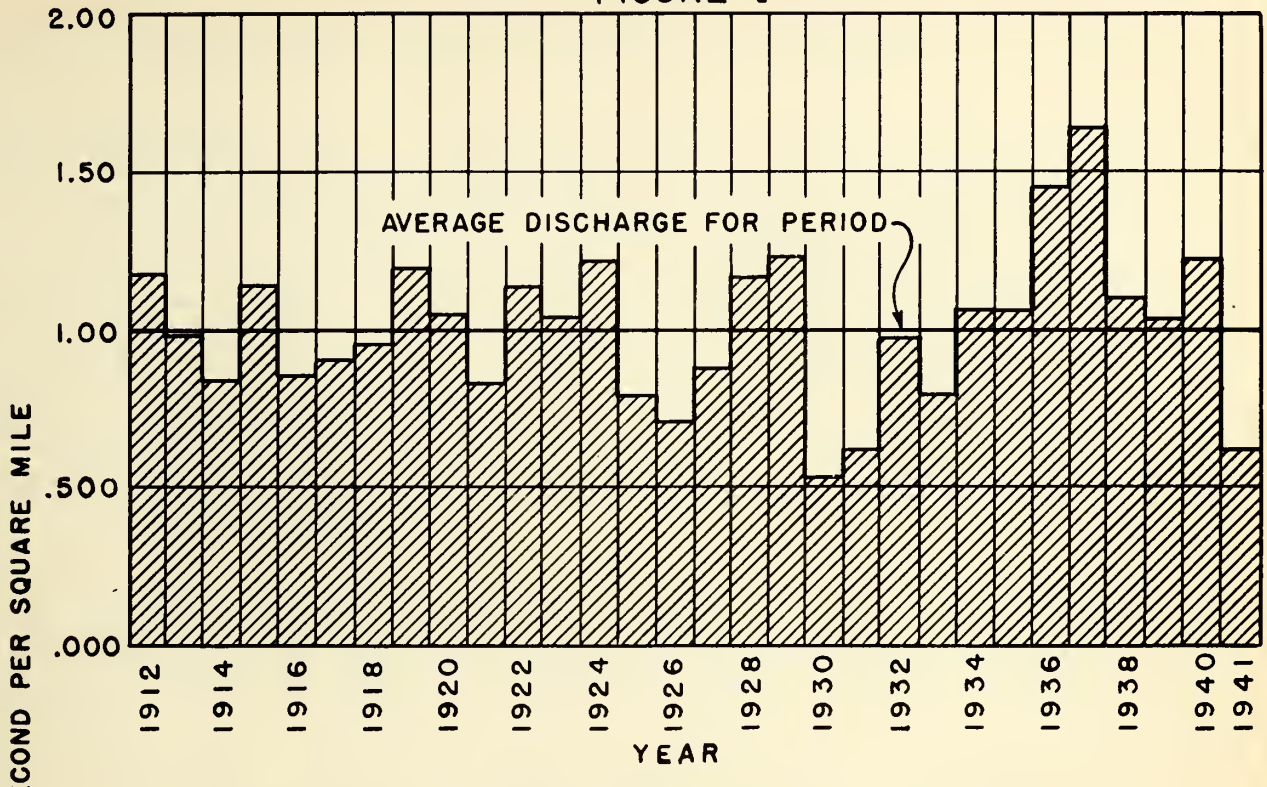


AVERAGE ANNUAL PRECIPITATION - ROANOKE RIVER BASIN 1891 TO 1941

CHART VII

AVERAGE DISCHARGE OLD GASTON, N.C., 1912 TO 1941

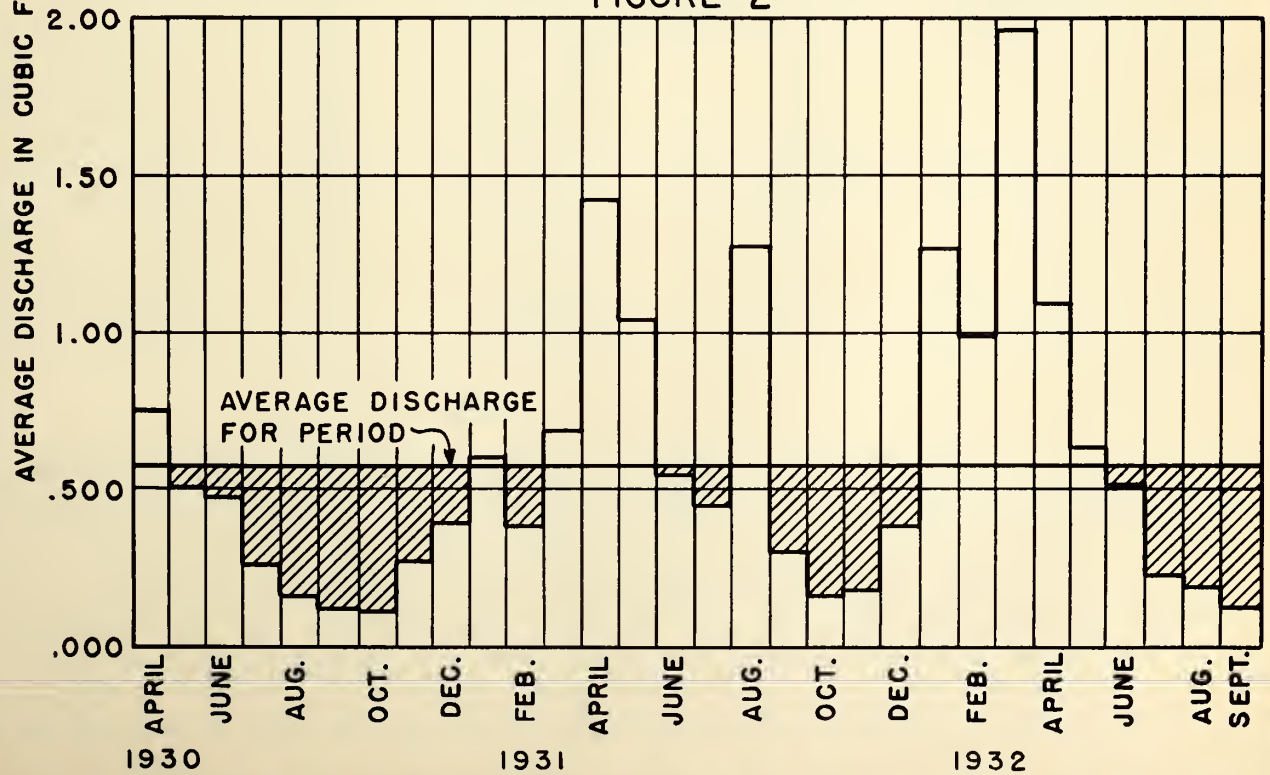
FIGURE 1



AVERAGE DISCHARGE IN CUBIC FEET PER SECOND PER SQUARE MILE

AVERAGE DISCHARGE OLD GASTON, N.C., DROUGHT PERIOD - 1930 TO 1932

FIGURE 2



AVERAGE DISCHARGE IN CUBIC FEET PER SECOND PER SQUARE MILE

SOURCE- REVIEW REPORT ON ROANOKE RIVER, U.S. CORPS OF ENGINEERS, TABLE B-6 APPENDIX, VOL. I

At this rate of flow it would require approximately six months to fill the power pool of Buggs Island Reservoir if no water was discharged from the lake and there were no losses.

FLOOD RECORDS - The crest stages of major floods at Weldon, N. C., from 1899 to 1944 are tabulated in Table VIII, page 70. The flood of August, 1940 was the largest of record throughout most of the basin. This resulted in a crest stage of 58 feet at Weldon, N. C., and a runoff of 5.1 inches over the drainage area. In November, 1877, the second largest flood of record occurred on the lower reaches of the river. This flood was the largest ever recorded in the headwaters of both the Roanoke and the Dan Rivers. Fragmentary records indicate that at a much earlier date a flood on the lower reaches exceeded that of 1877. It is possible that such a flood occurred in 1771, the same year as the tremendous flood on the James River. Downstream from Buggs Island, stages up to 34.4 feet at Weldon, N. C., cause practically no damage. During the period 1899 to 1944, 130 floods reached or exceeded a stage of 34.4 feet at Weldon, N. C.

Data on the major floods of record on the Smith River are given in Table IX. The flood of July, 1889, was the largest observed in the Smith River Basin and the flood of October, 1937, was the largest of recent record at and above Martinsville, Virginia, and that of August, 1940, the largest below Martinsville.

TABLE IX - MAJOR FLOODS, SMITH RIVER AT BASSETT
(Drainage area 257 square miles)
(Data from the Review Report, Corps of Engineers)

Date	Crest Stage Ft.	Peak Discharge Cfs.	Peak Discharge Cfs./Sq. Mi.	Flood Volume Ins. Runoff on Drainage Area
July 31, 1889	24*	41,000*	160*	- - -
May 21, 1901	22*	36,000*	140*	- - -
March 15, 1912	16*	21,000*	82*	- - -
March 17, 1923	17*	24,000*	93*	- - -
August 16, 1928	19.5	29,600	115	- - -
October 17, 1932	17.8	26,200	102	2.72
October 19, 1937	22.9	37,000	144	3.07
August 18, 1939	17.0	24,000	93	1.64
August 14, 1940	18.3	27,000	105	4.24

*Estimated

FLOOD OF AUGUST, 1940 - The storm causing this flood originated in the South Atlantic Ocean about August 10 and swept over most of the South Atlantic states. The center passed successively near Savannah and Macon, Georgia; Chattanooga, Tennessee; and Wytheville, Virginia. From this last point it turned to the southeast and swept western and central North Carolina. The storm, associated with a tropical hurricane, became blocked in its northward movement and was turned east along the Roanoke River Basin. The heaviest rainfall, 17.5 inches, was observed at Keysville, Virginia, on the northeasterly edge of and just outside the basin. Rainfall averaged 12.8

TABLE VIII - MAJOR FLOODS AT WELDON, N. C.
Drainage Area 8445 square miles
(Data from the Review Report, Corps of Engineers)

Date	Crest Stage Ft.	Peak Discharge Cfs.	Peak Discharge Cfs./Sq. Mi.	Flood Volume Ins. Runoff
August 18, 1940	58.0	260,000	30.8	5.10
March 18, 1912	50.3	160,000	18.9	2.61
September 22, 1945	48.9	- - -	- - -	- - -
September 22, 1944	48.6	- - -	- - -	- - -
May 25, 1901	47.8	136,000	16.1	2.19
January 23, 1936	46.5	117,000	13.9	1.98
January 2, 1902	46.5	- - -	- - -	- - -
August 28, 1908	45.8	- - -	- - -	- - -
October 7, 1929	45.6	111,000	13.1	2.05
July 23, 1919	45.2	99,000	11.7	3.31
October 8, 1902	45.2	- - -	- - -	- - -
October 24, 1937	45.0	103,000	12.2	1.80
March 20, 1923	45.0	- - -	- - -	- - -
March 21, 1936	44.8	- - -	- - -	- - -
August 16, 1928	44.8	107,000	12.7	1.43
August 21, 1928	44.5	99,000	11.7	1.33
March 26, 1903	44.7	- - -	- - -	- - -
March 18, 1913	44.4	- - -	- - -	- - -
July 28, 1938	44.2	- - -	- - -	- - -
January 7, 1936	43.7	- - -	- - -	- - -
December 4, 1934	43.3	86,000	10.2	2.24
January 7, 1937	43.2	- - -	- - -	- - -
February 18, 1936	43.0	- - -	- - -	- - -
October 21, 1932	42.7	90,000	10.7	1.31
October 4, 1924	42.4	- - -	- - -	- - -
February 20, 1903	42.2	- - -	- - -	- - -
April 28, 1937	42.1	- - -	- - -	- - -
January 23, 1937	42.0	- - -	- - -	- - -
September 23, 1928	42.0	- - -	- - -	- - -
May 15, 1912	41.4	- - -	- - -	- - -
January 6, 1919	41.3	- - -	- - -	- - -
March 8, 1917	41.3	- - -	- - -	- - -
March 1, 1902	41.0	- - -	- - -	- - -
March 10, 1932	40.8	72,000	8.5	1.45
June 24, 1938	40.3	- - -	- - -	- - -
February 7, 1920	40.3	- - -	- - -	- - -
March 3, 1902	40.3	- - -	- - -	- - -
October 1, 1944	40.2	- - -	- - -	- - -
August 22, 1939	40.1	70,000	8.3	1.07
March 2, 1929	40.0	- - -	- - -	- - -
January 14, 1925	40.0	- - -	- - -	- - -
April 24, 1918	40.0	- - -	- - -	- - -
November 27, 1877	54.3	250,000*	29.6*	- - -

*Estimated

inches over 8,000 square miles around a center at Keysville, Virginia. The average depth of rainfall on the watershed above Roanoke Rapids, N. C., was 10.1 inches. Three stations in the basin - Copper Hill, Randolph, and Clarksville, Virginia - recorded over 15 inches each.

This extreme rainfall produced the greatest flood of record on the Roanoke River below Brookneal, Virginia. The smaller rainfall on the lower Dan River, produced a severe flood but flood heights were exceeded on that reach in 1877, possibly exceeded in 1889, and were closely approached in 1912. The rainfall was not of sufficient intensity to produce record stages on the smaller tributaries but due to the long duration, the flood volume was unusually large. Data on this flood are included in Table X.

TABLE X - RAINFALL AND RUNOFF DATA - FLOOD OF AUGUST, 1940
ROANOKE RIVER AND TRIBUTARIES
(Data from the Review Report, Corps of Engineers)

Station	River	Drainage Area Sq. Mi.	Crest Stage Ft.	Crest Discharge Cfs.	Cfs./Sq. Mi.	Average Rainfall Inches	Volume of Runoff Acre-Feet
Roanoke	Roanoke	388	18.2	28,000	72	11.41	121,000
Niagara	Roanoke	511	17.5	35,000	68	10.93	168,000
Toshes	Roanoke	1,020	27.4	70,000	68	11.22	350,000
Altavista	Roanoke	1,802	40.1	105,000	58	11.05	610,000
Brookneal	Roanoke	2,420	46.0	130,000	54	10.75	850,000
Clover	Roanoke	3,230	37.2	160,000	49	11.30	1,050,000
Clarksville	Roanoke	7,320	26.7	280,000	38	9.94	2,070,000
Roanoke Rapids	Roanoke	8,410	39.0	261,000	31	10.09	2,290,000
Weldon	Roanoke	8,445	57.9	261,000	31	10.09	- - -
Scotland Neck	Roanoke	8,669	40.0	260,000	30	10.05	2,360,000
Williamston	Roanoke	9,000	20.4	236,000	26	9.89	- - -
Francisco	Dan	119	9.4	7,600	64	9.33	24,000
Wentworth	Dan	1,052	26.9	50,200	48	6.72	185,000
Danville	Dan	2,050	21.0	75,000	37	7.78	415,000
South Boston	Dan	2,730	31.8	81,000	30	7.79	527,000
Martinsville	Smith	374	19.5	34,200	91	8.83	90,000
Spray	Smith	540	19.3	38,000	70	8.60	127,000

The August, 1940, flood was the most destructive of all floods in the Roanoke River Basin. Three lives were lost and thousands made homeless. The flood inundated large tracts of agricultural land and many industrial plants and commercial establishments. Transportation and communication facilities were inoperative. Below is a summary of the losses which are also tabulated in Table XI.

(a) Urban - Twenty-four cities and towns sustained substantial losses. In Roanoke and Altavista, Virginia, and Roanoke Rapids, Weldon and Spray, N. C., the losses were $100,000 or more. Industrial plants on the flood plains suffered a large amount of damage. Approximately 19,000 persons, for the most part employed therein, were affected. Normal production was not resumed for as much as two months. Water supply systems of 10 municipalities were damaged and several did not operate for as long as 7 days.

TABLE XI - AUGUST, 1940 FLOOD LOSSES - ROANOKE RIVER BASIN
(Data from the Review Report, Corps of Engineers)

Section of Basin	Roanoke River		Dan River	Smith River	Smaller Streams	Total	Buggs Is. to Mouth plus Smith R.	Per Cent of Basin Total
	Headwaters Buggs Is.	Buggs Is. Mouth						
Area Inundated (Acres)								
Cleared	16,480	50,530	14,470	1,360	33,700	116,540	51,890	44.5
Total	34,680	228,130	28,970	1,820	62,140	355,740	229,950	64.6
Flood Losses								
Agricultural	$280,000	$1,551,000	$244,800	$ 22,000	$705,700	$2,803,500	$1,573,000	56.1
Communications								
and Utilities	134,100	414,000	73,200	3,000	116,500	740,800	417,000	56.3
Urban								
Domestic	6,200	12,000	1,700	14,000	3,100	37,000	26,000	70.3
Municipal	4,000	9,300	9,500	4,000	--	26,800	13,300	49.6
Commercial	50,600	21,800	8,300	12,000	19,400	112,100	33,800	30.2
Industrial	279,800	1,050,900	13,400	149,000	7,200	1,500,300	1,199,900	80.0
Relief Expenditures	3,000	54,000	--	--	--	57,000	54,000	94.7
Total Loss	$757,700	$3,113,000	$350,900	$204,000	$851,900	$5,277,500	$3,317,000	62.9

(b) Agricultural losses - The wide flood plain below Weldon, N. C., was completely inundated and the crops, which included cotton, peanuts, corn, soybeans and hay, were almost completely destroyed. Gardens and pastures were severely damaged. Many buildings, farm tools, and livestock were lost. Eight hundred and eighty farm units were inundated. The flood plains of the upper Roanoke and of the Dan and Smith Rivers are for the most part narrow. These plains are normally devoted to raising subsistence crops. There are few buildings located below the flood line. Practically the entire crop on these flood plains was destroyed by the 1940 flood but the monetary loss was not great. A small amount of farm improvement was damaged and several hundred head of cattle were drowned.

(c) Communication facilities - Practically all of the highway crossings above Weldon, N. C., were inundated and five bridges on the Roanoke River were destroyed. Below Weldon, N. C., two main highways which cross the Roanoke River were damaged, mainly by the breaching of approach fills. Most of the railroad bridges crossing the Roanoke River or their approaches were inundated. Sections of tracks on the flood plains were washed out. Portions of practically all the railroads in the basin were affected. Telephones were put out of commission.

(d) Other losses - The only hydroelectric plant damaged materially was the Virginia Electric and Power Company plant at Roanoke Rapids, N. C., which was out of operation for several months. Others were unable to operate during the period of high river stages. Power lines in the valleys were destroyed.

Relief agencies rendered aid at Altavista, Virginia, and Roanoke Rapids, N. C. Below Weldon, N. C., over 4,000 persons were driven from their homes and required relief. The U. S. Coast Guard assisted in evacuating these families. North Carolina State and County Health Departments established and maintained camps for 30 days after the flood. The Red Cross and the Federal Commodity Corporation furnished food and clothing. Extensive rehabilitation was carried on by the North Carolina State Board of Health and the Federal Works Project Administration after the flood. Chart IX gives the estimate of the damage on the Roanoke, Dan and Smith Rivers caused by this flood.

FLOOD OF OCTOBER, 1937 - This flood which reached major proportions in the Smith River drainage area resulted from a warm front storm during which the heaviest rainfall occurred where the mountain slopes were steepest. Flood stages on many small tributaries were the highest of record. Business, industry, and communications along the Smith River were affected but the damage was not widespread over the Roanoke River Basin.

(a) Urban losses along the Smith River were extensive; seven cities and towns sustained damage. This damage exceeded $350,000 at Bassett and $100,000 at Fieldale, Va. Relief agencies furnished food and clothing to about 150 families who were forced to evacuate their homes. Inoculation of several thousand persons, chlorination of domestic water supplies, and other precautionary measures were taken to prevent epidemics. About 3,500 persons employed by industrial plants located on the flood plain were affected and 1,550 persons were forced to evacuate their homes.

(b) Agricultural losses along the Smith River both in 1940 and 1937 were small, amounting to about $25,000 in each case.

(c) Other losses in the Smith River Basin included disruption of transportation with the destruction of a number of bridges and the inundation of several primary highways. The Norfolk and Western Railway along Smith River was damaged.

Table XII summarizes the damage in the Smith River Basin.

TABLE XII - OCTOBER, 1937 FLOOD LOSSES IN THE SMITH RIVER BASIN
(Data from the Review Report, Corps of Engineers)

Damage Center	Cleared Area Inundated (Acres)	Flood Losses			
		Agricultural	Urban	All Other Property	Total
Philpott, Va.	10	- - -	$ 1,300	- - -	$ 1,300
Bassett, Va.	220	- - -	361,500	- - -	361,500
Stanleytown, Va.	10	- - -	72,300	- - -	72,300
Fieldale, Va.	50	- - -	105,100	- - -	105,100
Koehler, Va.	40	- - -	23,600	- - -	23,600
Martinsville, Va.	10	- - -	12,000	- - -	12,000
Spray, N. C.	20	- - -	30,700	- - -	30,700
Rural Area	1,310	$26,600	- - -	$13,600	40,200
Total	1,670	$26,600	$606,500	$13,600	$646,700

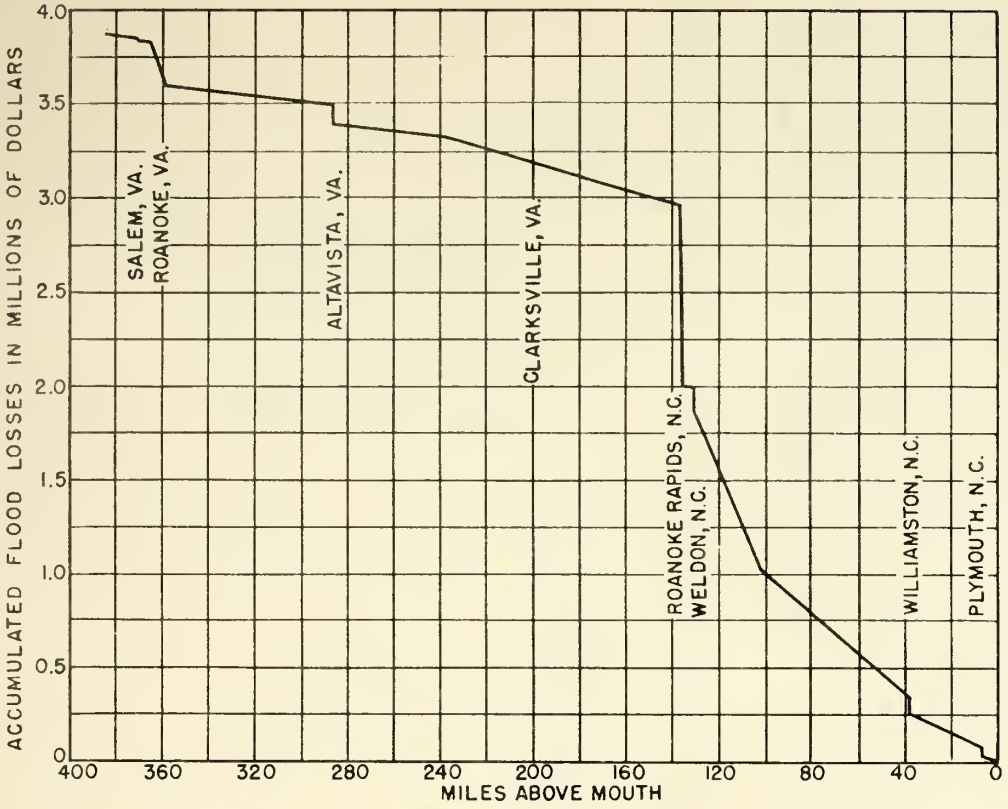
FLOOD FREQUENCY - The Corps of Engineers investigated the flood hazards of the Roanoke, Dan, and Smith Rivers. The results of these investigations for Roanoke Rapids, N. C., Bassett, Va., and Martinsville, Va., are given in Table XIII. As pointed out later, the Buggs Island and Philpott multiple purpose reservoirs will accomplish large reductions in stage at these points.

Flood damages begin to occur at approximately the following gage heights.

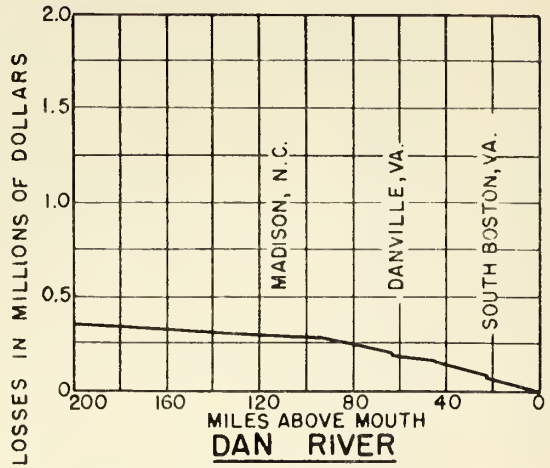
Bassett, Va.	gage height 17.0
Martinsville, Va.	gage height 15.5
Weldon, N. C.	gage height 34.0

The Buggs Island Reservoir is designed to reduce a natural flood flow of 270,000 cubic feet per second at the dam site to a controlled outflow of 60,000 cubic feet per second. The flood storage reservation without surcharge is 1,345,000 acre-feet which is equivalent to 3.23 inches of runoff over the drainage area. If, at the time of occurrence of the flood, the power pool is below its maximum elevation a further reduction of outflow is possible. This design flood flow equals that of August, 1940, at the Buggs Island site. The spillway is designed to discharge 770,000 cubic feet per second with a pool elevation of 325, which provides a margin of safety for the structure of nearly three times the maximum natural flood flow of record at the site.

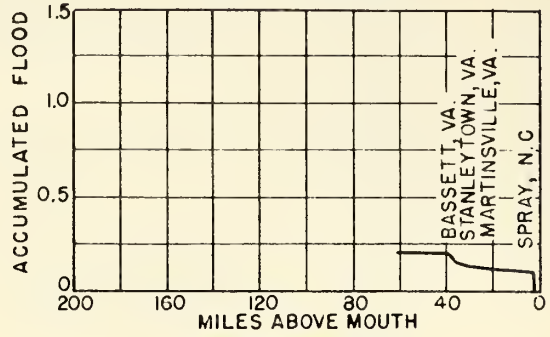
ESTIMATE OF 1940 FLOOD LOSSES



ROANOKE RIVER



DAN RIVER



SMITH RIVER

SOURCE- REVIEW REPORT ON ROANOKE RIVER, U.S. CORPS OF ENGINEERS.

CHART IX

TABLE XIII - PROBABLE FLOOD FREQUENCY
ROANOKE RIVER AND TRIBUTARIES
(Data from the Review Report, Corps of Engineers)

Average Occurrence Interval	Roanoke River at Roanoke Rapids, N.C.		Smith River at Bassett, Va.		Smith River at Martinsville, Va.		Average Chance of Occurrence
Years	Gage Height Ft.	Discharge Cfs.	Gage Height Ft.	Discharge Cfs.	Gage Height Ft.	Discharge Cfs.	% Per Year
1	18.0	70,000	10.9	13,100	11.6	14,000	100
2	20.5	85,000	13.7	17,600	13.9	15,700	50
5	24.2	114,000	17.4	25,000	17.0	26,600	20
10	27.2	136,000	19.9	30,600	19.3	32,900	10
20	30.2	163,000	22.5	36,600	21.3	39,000	5
50	34.4	204,000	25.3	44,300	24.0	47,000	2
100	37.5	238,000	27.3	50,300	26.1	54,000	1
1000	48.6	420,000	33.7	71,000	32.6	77,000	0.1

The Philpott No. 4 Reservoir is designed to reduce a flood of 29,600 cubic feet per second, such as the 1937 flood, to an inconsequential amount. The controlled flood storage amounts to about 34,000 acre feet which is equivalent to about three inches of runoff over the drainage area. The spillway is designed to pass a total outflow of 31,000 cubic feet per second. In the case of the spillway design flood this would allow a maximum rate of inflow of 150,000 cubic feet per second by storage of 77,000 acre feet of surcharge or 6.8 inches of runoff over the drainage area. This inflow is equivalent to five times the maximum flood flow of record.

Below is the effect, as estimated in the Review Report, Corps of Engineers, the Philpott No. 4 Reservoir would have on past floods.

Locality	Damage Stage Feet	Data	Stages and Reduction in Feet for the Following Floods: Oct. 1937	Aug. 1939	Aug. 1940
Bassett, Va.	17.0	Stage of Flood	22.9	17.0	18.3
		Modified Stage	9.3	7.1	7.0
		Reduction	13.6	9.9	11.3
Martinsville, Va.	15.5	Stage of Flood	21.5	16.8	19.5
		Modified Stage	12.5	12.2	18.5
		Reduction	9.0	4.6	1.0
Spray, N. C.	16.5	Stage of Flood	22.5	16.3	23.9
		Modified Stage	19.3	12.2	21.1
		Reduction	3.2	4.1	2.8

ROANOKE RIVER BASIN REPORT

SECTION IV

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AUTHORIZED DEVELOPMENTS

GENERAL - In the Review Report on the Roanoke River forwarded to Congress on May 30, 1944 by the Secretary of War, and subsequently approved by Public Act 534, 78th Congress, the District Engineer made several recommendations in which, in general, the Division Engineer, the Board of Engineers for Rivers and Harbors, and the Chief of Engineers concurred.

These recommendations were:

First - The adoption of the comprehensive plan proposed in the Review Report for the orderly development of the water resources of the basin. The Board of Engineers in its review of the report states as follows: "The comprehensive plan of improvement, consisting of eleven developments for hydroelectric power, flood control, navigation and other uses, provides the best plan for the development of the water resources of the Roanoke River Basin."

At the time of preparation of the Review Report in 1943 this complete development was estimated to cost the Federal Government for construction including necessary transmission facilities but excluding interest during construction, $124,000,000 and for annual operation and maintenance, $657,800. The total annual charges, exclusive of transmission facilities, were estimated at $5,223,300 and the annual benefits were estimated at $7,692,400 consisting of $7,281,400 for hydroelectric power, $369,000 for flood control, $10,000 for low water regulation benefits, and $32,000 for benefits to several small existing downstream plants. Annual output was estimated at 1,229,700,000 kilowatt-hours of primary energy and 465,500,000 kilowatt-hours of secondary energy. This study indicated the economic feasibility of the comprehensive development, step by step, as the power market expanded.

Second - The authorization of construction in the near future of the Buggs Island and Philpott Projects. These two projects include the principal flood control features of the final development and were estimated by the Corps of Engineers to eliminate over 90 per cent of the flood losses to the main flood damage areas of the basin and 68 per cent of the total preventable flood losses. The Review Report estimated that Buggs Island alone as an initial development would produce annually 278,000,000 kilowatt-hours of primary and 153,000,000 kilowatt-hours of secondary energy. These estimates are undergoing further revision by the Corps of Engineers and will be discussed more fully later in this report. Philpott No. 4 as an initial development was estimated to produce annually 22,400,000 kilowatt-hours of primary and 1,200,000 kilowatt-hours of secondary energy. In addition, by river regulation, Philpott No. 4 would appreciably increase the annual output at Buggs Island. The Buggs Island Project would also greatly benefit the two projects downstream at Gaston and Roanoke Rapids, N. C., by increasing their low water flow. When these two plants are developed, the power generated could be marketed over the same system.

BUGGS ISLAND PROJECT
(From "Pertinent Data", Dated March 13, 1946, of the Corps of Engineers)

LOCATION AND DESCRIPTION - The dam site is located on the Roanoke River in Mecklenburg County, Virginia, about 178.7 miles above the mouth and 20.3 miles downstream from Clarksville, Virginia. The drainage area above the dam is 7,800 square miles, which is 81 per cent of the total Roanoke River drainage area and 93 per cent of that above Roanoke Rapids, N. C. The dam consists of non-overflow concrete gravity sections on both banks; a concrete gravity spillway section, gate controlled; a concrete gravity power intake section; and wing and saddle dikes on both banks. The foundation is granite gneiss.

The principal dimensions are as follows:

Length--	
Right Earth Wing and Saddle Dike	9,100 ft.
Non-overflow Section, Right Bank	600 ft.
Spillway	1,150 ft.
Intake to Power House	647 ft.
Non-overflow Section, Left Bank	400 ft.
Left Earth Wing and Saddle Dike	10,600 ft.
Total Overall Length	22,500 ft.
Maximum Height--	
Concrete Section	144 ft.
Earth Fill Sections	45 ft.
Maximum Width at Base--	
Spillway Section Only	106 ft.
Spillway Section Including Apron	140 ft.
Crest Gates--	
Type	Tainter
Number	22
Size (Length and Height)	42 by 32 ft.
Capacity at Pool Elevation 325	770,000 cfs.
Sluices--	
Number and Size	Ten 5 ft. 8 in. by 10 ft. inlets
Capacity at Pool Elevation 300	30,000 cfs.
Elevation in Terms of Mean Sea Level--	
Top of Dam	332
Flood Plain (General Elevation)	212
Base of Dam (approx.)	
Concrete Portion (Lowest)	188
Crest of Spillway	288
Top of Crest Gates	320
Maximum, Controlled Flood Pool	320
Maximum, Water Surface (Spillway Design Flood)	325
Maximum, Power Pool	300
Usual Minimum Power Pool	280
Occasional Minimum Power Pool	268

The initial installation for power consists of three units of 32,000 kilowatts each, one unit of 12,000 kilowatts, and two station service units of 1,000 kilowatts each. Provision will be made for an ultimate installation of three addi-

tional units of 32,000 kilowatts each. The power house will have a structural steel framework with a brick superstructure. The generators will be driven by Francis type, vertical shaft hydraulic turbines; the three main units of the initial installation are rated at 51,000 horsepower each at 90 foot net head.

The total discharge from the plant will be 19,670 cubic feet per second at 90 foot head for the initial installation and 36,770 cubic feet per second for the ultimate installation. The plant will have a gross primary capacity of 23,000 kilowatts and a net of 20,700 kilowatts. The dependable capacity at 23 per cent capacity factor is 90,000 kilowatts. The minimum annual energy output is estimated at 200,000,000 kilowatt-hours and the average at 410,000,000 kilowatt-hours.

The construction quantities are estimated as follows:

Concrete	700,000 cu. yd.
Earth excavation	500,000 cu. yd.
Rock excavation	300,000 cu. yd.
Earth fill	1,200,000 cu. yd.

The reservoir at the maximum controlled flood elevation of 320 will inundate 63,420 acres in Mecklenburg, Charlotte, and Halifax Counties, Virginia, and 24,480 acres in North Carolina. (See Page 18.) This includes 4,280 acres in the present river channel. Plate VII shows the reservoir and surrounding territory. The reservoir will extend to near South Boston, Virginia, on the Dan River and Randolph, Virginia, on the Roanoke River.

Data pertinent to the reservoir are given below:

Length at Elevation 320--	
Roanoke River	56 miles
Dan River, above junction	34 miles
Length of Shore Line at Elevation 300--	800 miles
Maximum Width at Elevation 300--	2 miles
Storage (Flat Pool Assumption)--	
Total Volume at Elevation 325	3,392,000 acre-feet
Uncontrolled Flood Storage (Elev. 325-Elev. 320)	471,000 acre-feet
Controlled Flood Storage (Elev. 320-Elev. 300)	1,345,000 acre-feet
Power Storage (Elev. 300-Elev. 268)	1,085,000 acre-feet
Unusable Storage (Below Elev. 268)	491,000 acre-feet
Reservoir Surface (Flat Pool Assumption)--	
At Maximum Controlled Flood Pool (Elev. 320)	87,900 acres
At Maximum Power Pool (Elev. 300)	51,200 acres
At Minimum Power Pool (Elev. 268)	20,300 acres
Land and Acquisitions (Va. and N. C.)--	
Property to be Acquired	107,900 acres
Annual Tax Loss to Counties	$31,000
Families Displaced, Total	380
Rural	325
Urban	55

Urban Areas Affected--Soudan, Buffalo Springs, Keats, Clarksville, Virginia	
The reservoir, except during very high flood periods, will have no effect at South Boston, Virginia when the pool is at or below maximum power pool elevation. The Corps of Engineers estimates that should the August, 1940 flood recur with the reservoir at maximum power pool elevation, the backwater effect caused by Buggs Island Dam would raise the flood stage at South Boston approximately $1\frac{1}{2}$ feet higher than the flood stage that actually occurred at South Boston in 1940. If the power pool was drawn down as scheduled, the backwater effect at South Boston would be less than one foot in such a flood. After the construction of the Philpott No. 4 Dam on Smith River, this possible backwater effect at South Boston would be further reduced.	
Schools Affected--Keats, Antioch, Clarksville (all colored)	3
Farms in Area Below Elevation 320--	325
Cleared Area--	
Between Elev. 320 and Elev. 300	11,200 acres
Below Elev. 300	15,100 acres
Alterations and Relocations--	
Highways	
Primary	16 miles
Secondary	14 miles
Total	30 miles
Railroads	22 miles
Transmission and Distribution Lines	47 miles
Telephone Lines	20 miles
Telegraph Lines	18 miles
Pipe Lines	2 miles
Cemeteries, Approx. Number Graves	2,100

The storage uses are shown graphically on Chart X.

FLOOD LOSSES AND BENEFITS - A river development which by flood storage reduces the magnitude of future floods thereby reduces the corresponding flood losses and such reductions may properly be credited to the development as benefits. The past performance of a stream in causing flood losses is the principal reliance in predicting probable future losses. Generally speaking, these future reductions in flood losses are determined as the difference between the estimates of future flood losses for the natural or unregulated stream and those of the stream after a degree of regulation has been imposed by the development. Such estimates of the flood benefits thus accruing to a development must finally be expressed in terms of a probable average annual future benefit for inclusion in the yearly balance sheet of total charges and total benefits which may, or may not, reveal economic justification for the project. The making of such an estimate is not a simple affair. It requires very careful and very extensive investigations covering the past behavior of the stream, the economic development of the flood plain, and the losses caused by past floods. Such investigations have been carried out by the Corps of Engineers in great detail for the flood plain of the Roanoke River.

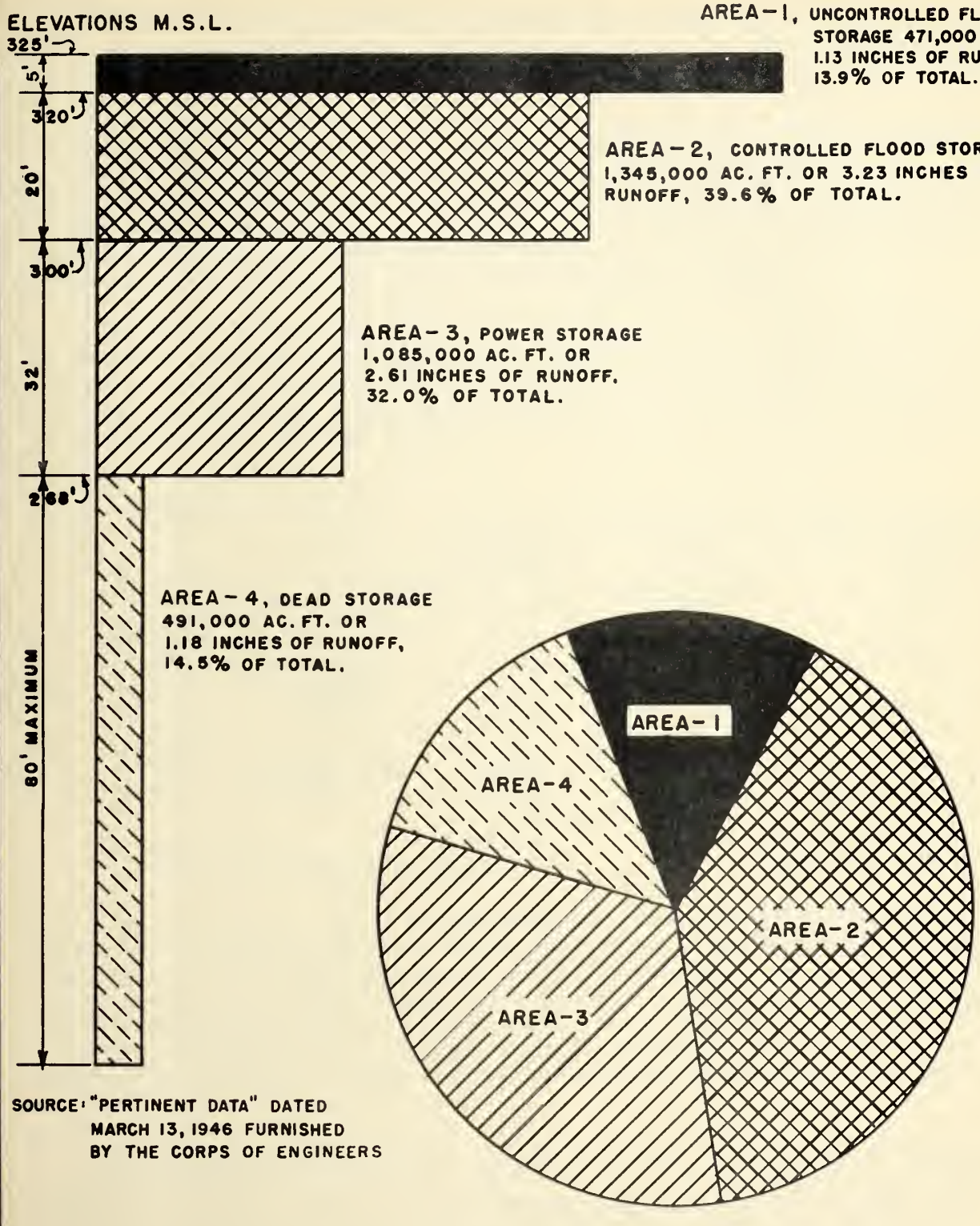
VIRGINIA STATE PLANNING BOARD
RIVER BASIN COMMITTEE

ROANOKE RIVER BASIN STUDY

BUGGS ISLAND RESERVOIR

EXISTING TRANSPORTATION SYSTEM

SEPTEMBER 1946


ELEVATIONS M.S.L.
325'
5'
320'
20'
300'
32'
268'
80' MAXIMUM
AREA-1, UNCONTROLLED FLOOD STORAGE 471,000 AC. FT. OR 1.13 INCHES OF RUNOFF, 13.9% OF TOTAL.
AREA-2, CONTROLLED FLOOD STORAGE 1,345,000 AC. FT. OR 3.23 INCHES OF RUNOFF, 39.6% OF TOTAL.
AREA-3, POWER STORAGE 1,085,000 AC. FT. OR 2.61 INCHES OF RUNOFF, 32.0% OF TOTAL.
AREA-4, DEAD STORAGE 491,000 AC. FT. OR 1.18 INCHES OF RUNOFF, 14.5% OF TOTAL.
AREA-1
AREA-4
AREA-2
AREA-3

SOURCE: "PERTINENT DATA" DATED MARCH 13, 1946 FURNISHED BY THE CORPS OF ENGINEERS

STORAGE VOLUMES
BUGGS ISLAND RESERVOIR

For the purpose of flood loss studies the Roanoke River was divided into ten reaches, the Dan into five, and the Smith into three which were established as damage zones. These damage zones are shown on accompanying Chart XI.

The field surveys were made in such a manner as to furnish estimates of flood damage to property from a number of past typical floods and from these data there resulted a reasonable stage-property loss relationship. In the case of crops, the amount of loss was corrected by applying a factor dependent upon the month of occurrence of the flood. This relationship when correlated with the probable frequency of recurring floods yielded ultimately an estimate of the probable average future property damage per annum.

The result of these studies for all the damage zones of the Roanoke River Basin is reported in the Review Report by the Corps of Engineers in a consolidated table of "Estimated Average Annual Flood Damage" for the Roanoke, the Dan, and the Smith Rivers. The following quotation of the average annual flood damages for damage zones R7, R8, R9 and R10 is an excerpt from this table.

Zone No.	From	To	Annual Flood Damages			
			To Crops and Farm Improvements	To All Other Developments	Total	Per Cent of Basin Total
R7	Buggs Island	Weldon	$ 12,300	$51,200	$ 63,500	12.1
R8	Weldon	Scotland Neck	64,200	1,200	65,400	12.5
R9	Scotland Neck	Williamston	105,700	1,600	107,300	20.4
R10	Williamston	Mouth	1,950	5,250	7,200	1.4
	Total		$184,150	$59,250	$243,400	46.3
	Total for Roanoke River Basin				$524,800	100.0

Chart XI shows certain typical stage-loss and stage-inundated graphs. Of particular interest on Chart XI are the graphs of accumulated average annual flood losses from the mouth of the Roanoke River to its source. One graph shows the existing losses; i. e., probable average annual future losses for the unregulated stream; another shows these flood losses as they will probably be modified by the Buggs Island Development; a third shows the resulting flood damages as they will be modified on the Roanoke River by the proposed complete development.

The estimates herein quoted and the drawings exhibited are from the Review Report dated 1943. The March, 1946, revision of plans for the Buggs Island Development allotted to flood storage considerably more space in this reservoir and the evaluation of damages by the September, 1944, and 1945 floods increased the annual estimated flood losses. Additional data, and further study increased the estimated annual flood damages from $243,400 to $267,000 and the annual flood benefits from $207,000 to $267,000. It is estimated that the flood benefits from the Buggs Island Development will accrue $8,000 to Virginia and $259,000 to North Carolina.

The above values of annual flood damages and annual flood benefits are on the basis of property and crop values estimated from indices of purchasing power of the dollar at the time of preparation of the Review Report. No corrections have been applied for subsequent change in purchasing power of the dollar.

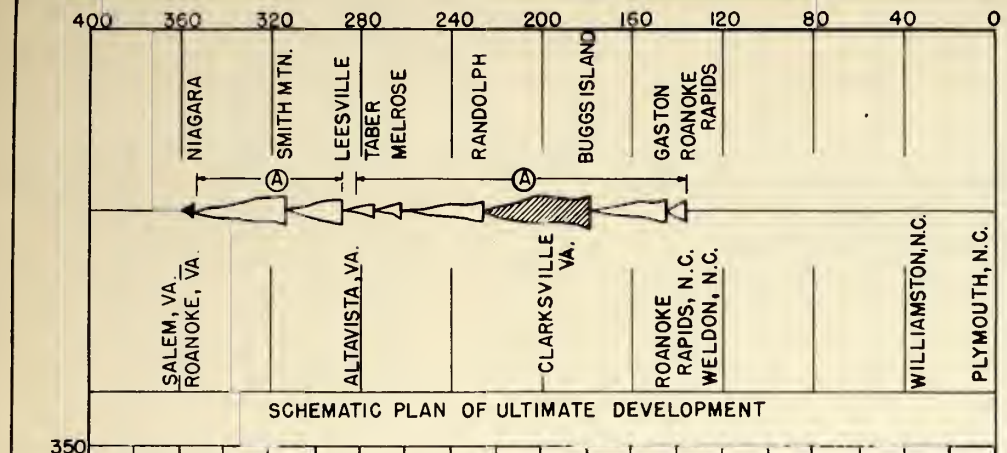
Table XIV gives the estimated flood damage below Buggs Island for twelve major floods.

TABLE XIV - ESTIMATED LOSSES FROM PAST FLOODS
ROANOKE RIVER BELOW BUGGS ISLAND
(Data taken from the Review Report and supplemental information furnished by the Corps of Engineers)

Date of Flood at Weldon, N. C.	Flood Damage		
	Crops	Other	Total
August 18, 1940	$1,027,000	$2,088,000	$3,115,000
September 22, 1945	618,000	190,000	808,000
May 25, 1901	399,000	130,000	529,000
August 28, 1908	419,000	77,000	496,000
September 22, 1944	417,000	64,000	481,000
July 23, 1919	387,000	64,000	451,000
March 18, 1912		445,000	
August 16, 1928	351,000	54,000	405,000
October 7, 1929	299,000	72,000	371,000
July 28, 1938	326,000	42,000	368,000
October 8, 1902	280,000	64,000	344,000
October 24, 1937	270,000	60,000	330,000

Table XV gives the value of the property on the flood plain, exclusive of land values. It should be noted that the value of the structures and improvements on the flood plain from Buggs Island Dam to the mouth of the Roanoke River totals $19,037,000.

The storage reserved for floods, 3.23 inches of runoff from the drainage area, would have reduced the maximum discharge of record (1940) at Buggs Island from 270,000 cubic feet per second to 60,000 cubic feet per second and the stage at Weldon, N. C., from 58 feet to less than 40 feet. No recorded flood on the Roanoke River except that of 1940 would have exceeded a maximum out-flow of 35,000 cubic feet per second, which is well below the no-damage stage. Based on the curves of Chart XI, a stage of 34 feet at Weldon, N. C., represents about the upper limit of "no-loss." Stages from 34 to 40 feet produce little damage except to crops in season. Stages from 40 to 48 feet endanger property in addition to increased crop losses. Above the 48 foot stage, flood damage increases at an alarming rate. On the average, a flood stage, of 40 feet is equalled or exceeded at Weldon, N. C., every year. Below Weldon, N. C., a 40 foot stage floods only a small amount of cleared land and produces a correspondingly small loss.



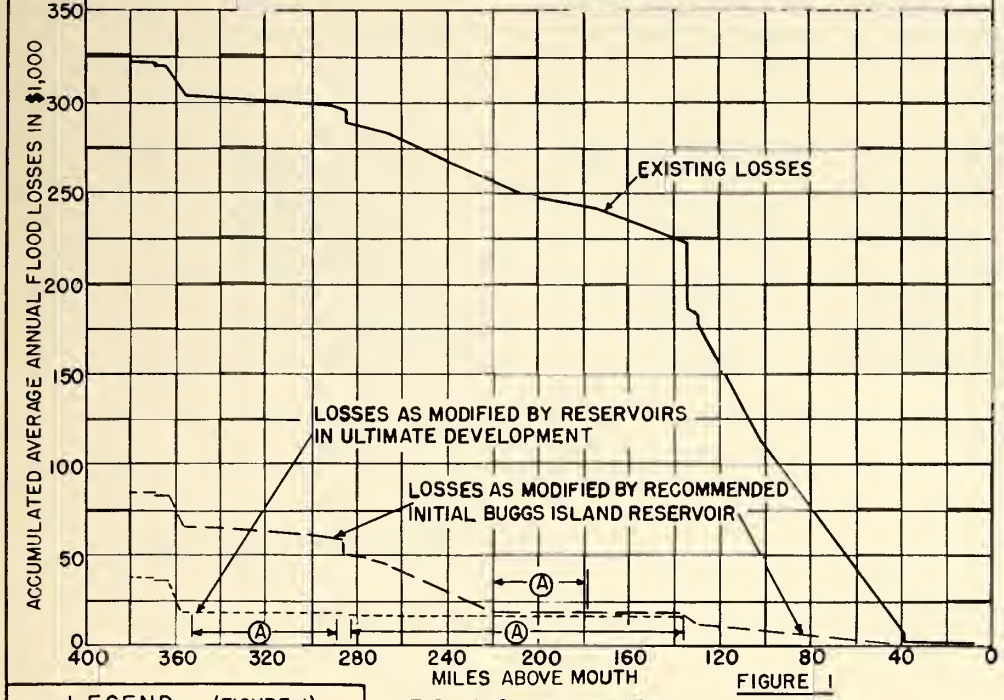
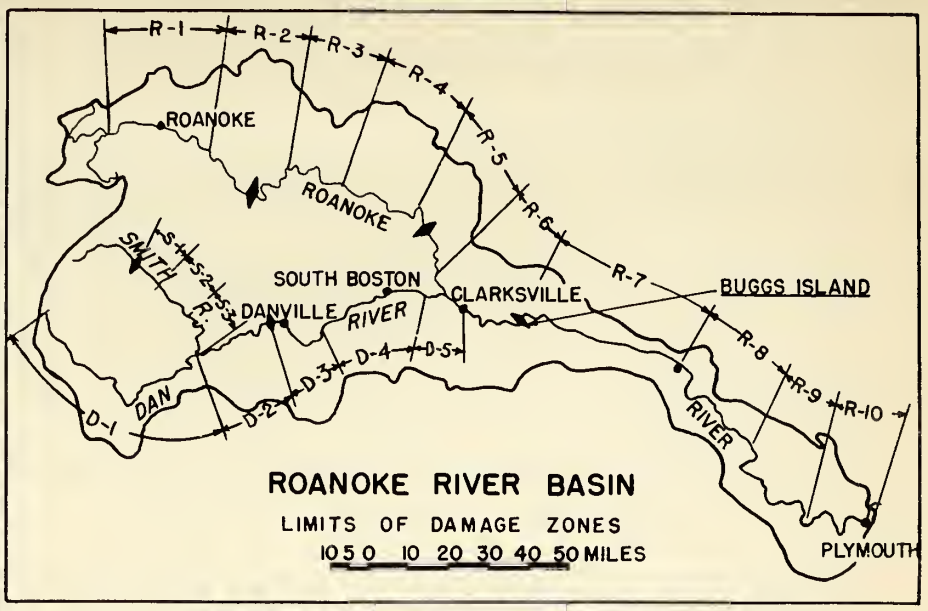


FIGURE 1



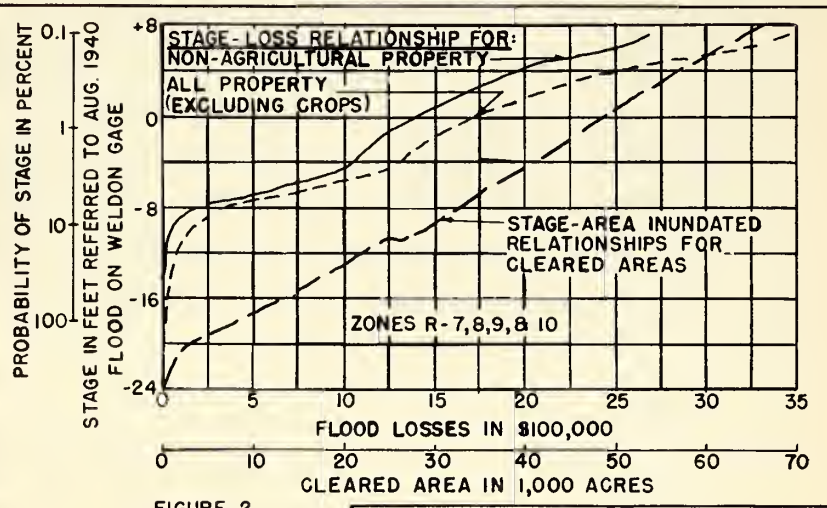


FIGURE 2

- LEGEND - (FIGURE 1)

◀ EXISTING RESERVOIRS

RECOMMENDED INITIAL RESERVOIRS

RECOMMENDED RESERVOIRS IN ULTIMATE DEVELOPMENT

Ⓐ DAMAGEABLE PROPERTY TO BE REMOVED BECAUSE OF INUNDATION OF FLOOD PLAIN BY RESERVOIRS

ROANOKE RIVER

FLOOD LOSSES ROANOKE RIVER

CHART XI

TABLE XV - VALUE OF PROPERTY ON FLOOD PLAIN
EXCLUSIVE OF LAND VALUE
ROANOKE RIVER BELOW BUGGS ISLAND
(Data from Review Report, Corps of Engineers)

Zone No.	R-7	R-8	R-9	R-10	Total	Total Roanoke River Basin
Type of Improvement						
Industrial	$5,119,000	$ --	$ --	$7,485,000	$12,604,000	$49,549,000
Commercial	211,000	--	--	427,000	638,000	2,673,000
Residential	57,000	177,000	375,000	41,000	650,000	1,651,000
Communications and Utilities	1,429,000	53,000	379,000	61,000	1,922,000	10,813,000
Public Structures	723,000	797,000	17,000	818,000	2,355,000	4,355,000
Farm Improvements	45,000	407,000	382,000	34,000	868,000	1,329,000
Total	$7,584,000	$1,434,000	$1,153,000	$8,866,000	$19,037,000	$70,370,000
Per Cent of Roanoke River Basin	10.8	2.0	1.6	12.6	27.0	100.0

TAX LOSSES AND IN LIEU PAYMENTS - The Corps of Engineers in attachments to a letter dated July 13, 1946, furnished an estimate of the total cost of real estate in the reservoir area, the total area to be purchased, and for each county the tax loss resulting from the land purchased and the area inundated at maximum flood pool. From these, the acreage to be purchased and its value has been estimated by this committee. These last estimates together with the Corps of Engineers estimate of county tax loss are shown in Table XVI.

TABLE XVI - ESTIMATED VALUE OF PROPERTY IN BUGGS ISLAND RESERVOIR

County	Acres to be Acquired	Estimated Total Value Land and Improvements	Present Property Tax Revenue
Charlotte	3,299	$ 108,579	$ 829
Halifax	20,899	702,972	4,629
Mecklenburg	54,960	2,397,887	12,508
Total Virginia	79,158	3,209,438	17,966
North Carolina	28,742	1,235,882	12,835
Total Purchase	107,900*	$4,445,320	$30,801

* 4,280 acres in river bed.

The Federal Government is considering, but as yet has not established, a fixed policy for payments in lieu of taxes lost locally by its purchase of land for flood control and other purposes in connection with river developments. (See House Document No. 216, 78th Congress, first session, not published herein.) However, Section 7 of the Flood Control Act of 1941 reads as follows:

> "Sec. 7. That 25 per centum of all moneys received and deposited in the Treasury of the United States during any fiscal year on account of the leasing of lands acquired by the United States for flood control purposes shall be paid, at the end of such year, by the Secretary of the Treasury to the States in which such property is situated, to be expended as the State legislature may prescribe for the benefit of the public schools and public roads of the county or counties in which such property is situated: Provided, that when such property is situated in more than one State or county the distributive share to each from the proceeds of such property shall be proportional to its area there."

As applied to Buggs Island and other developments in the Roanoke River Basin, this provision appears to indicate that lands acquired by the Federal Government but not permanently inundated may be leased to private enterprise and 25 per cent of the money received from such leases shall be paid to the State for expenditure in the counties affected. In the case of land permanently inundated, or occasionally inundated but not leased, The Federal Government assumes no obligation for payments in lieu of taxes. It is interesting to note that the Corps of Engineers estimates in Pertinent Data that the average annual benefit from rentals of cleared land and from timber sales will average $41,000.

Section 13 of the law governing the Tennessee Valley Authority prescribes a formula for payments in lieu of taxes based on the gross revenues received from power operations and distributed on the basis of power property in the counties and the states. This law applies to the Tennessee Valley Authority only, "A Government Corporation," and does not set a precedent for any other projects operated by any other government agency.

Payments under the TVA Act are given in Table XVII for the years ending June 30, 1944 and June 30, 1945.

TABLE XVII - COMPARISON OF FORMER PROPERTY TAXES WITH TAX EQUIVALENTS AND TAXES PAID BY TVA AND ITS DISTRIBUTORS FOR THE YEARS ENDED JUNE 30, 1944 AND 1945
(Data Furnished by TVA)

	1944	1945
Former Property Taxes		
On Property Acquired by TVA		
All Reservoir Land		
State & Municipal	$ 43,842	$ 45,359
County & District	366,727	385,654
Total	$ 410,569	$ 431,013
Purchased Power Property		
State and Municipal	$ 129,792	$ 128,627
County & District	838,152	815,717
Total	$ 967,944	$ 944,344
On Property Owned & Acquired by Distributors		
State and Municipal	$ 869,038	$ 869,038
County & District	686,723	686,723
Total	$1,555,761	$1,555,761
Total Former Property Taxes	$2,934,274	$2,931,118
Former State & Local Business Taxes	775,000*	775,000*
Total	$3,709,274	$3,706,118
In Lieu Tax Payments		
By TVA		
To States	$1,135,526	$1,114,958
To Counties	1,033,298	1,022,526
Total	$2,168,824	$2,137,484
By Distributors	$1,892,990	$2,001,541
Total Payments	$4,061,814	$4,139,025

*Estimated by TVA

POWER BENEFITS - An inspection of the breakdown of the benefits to be derived from the Buggs Island Project indicates that water power constitutes the major economic justification of the project. The other desirable results from the multiple-purpose reservoir must be incidental to the predominant use of the reservoir for water power. Water power must necessarily bear the greater portion of the costs and charges for the project. The immediate prospective benefits of reducing flood damages and increasing low water flows for improved domestic and industrial water supply and pollution abatement are relatively small.

As water power is the controlling factor in the development, the marketing of this water power is of prime importance in determining the economic feasibility of the Buggs Island development.

The Federal Power Commission has made several "Power Market Studies" and reports in connection with river basin developments and these are as follows:

Potomac River Basin - Power Supply Areas 5, 6, 7, 9, 10 and 18
Rappahannock River Basin - Power Supply Area 18
Roanoke River Basin - Power Supply Areas 18 and 21
James River Basin - Power Supply Areas 10 and 18

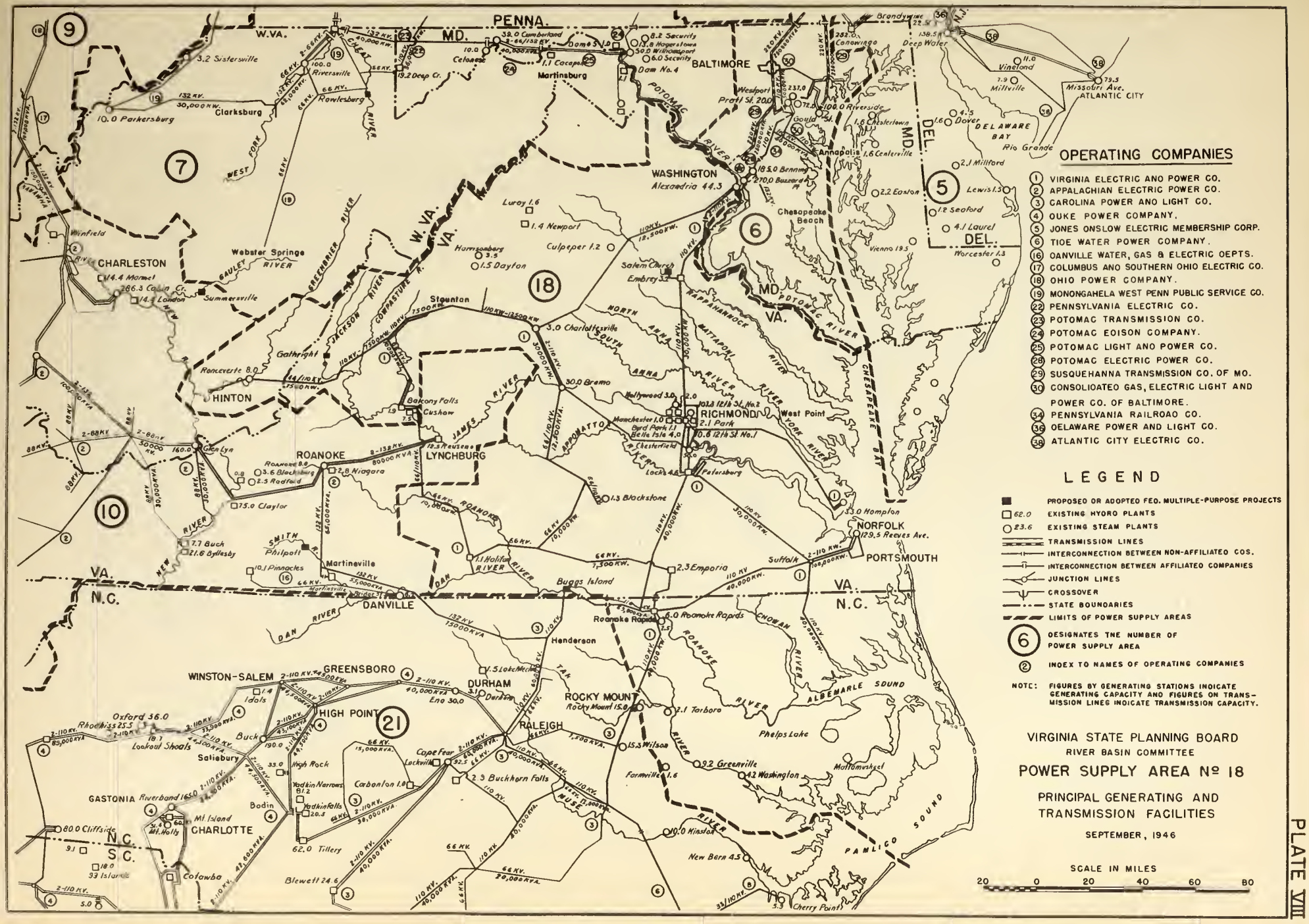
The Power Supply Areas are shown wholly or in part on Plate VIII.

All of these reports have been studied by the authors of this report. The power market study for the James River Basin covering Power Supply Areas 10 and 18 is the most recent and furnishes estimates of the loads to be expected after the war in these areas. This report is dated May, 1945 and is the principal source of data used in the discussion which follows:

Power Supply Area 21 is well supplied by large capacity hydroelectric installations. These will compete with the Buggs Island Project for the same portions of load in that area and to a lesser extent in Power Supply Area 18. In addition, the Corps of Engineers, in its power analysis, states that the displacement of the cheap peak steam power in Power Supply Area 10 is not certain. For the above reasons, it appears that the Buggs Island Development must find its principal power market in Power Supply Area 18. This area covers approximately 70 per cent of the State of Virginia and is contiguous to the Buggs Island Dam.

The boundary of Power Supply Area 18 together with fringes of abutting areas is shown on Plate VIII. The existing distribution and generating facilities and the authorized Federal "Multiple-purpose" projects are also indicated.

The Federal Power Commission has compiled data on the yearly generation by utilities since 1927 and by industry for its own use since 1939. These data are given in Table XVIII and plotted on Chart XII together with the Commission's estimates of consumption to 1970. Index numbers with 1940 as 100 have also been computed and these are likewise shown in Table XVIII and plotted on Chart XIII. The year 1940 was taken as the index as it is considered to be the most recent year of normal operation and not influenced by war conditions.



OPERATING COMPANIES

1. VIRGINIA ELECTRIC AND POWER CO.
2. APPALACHIAN ELECTRIC POWER CO.
3. CAROLINA POWER AND LIGHT CO.
4. DUKE POWER COMPANY.
5. JONES ONSLOW ELECTRIC MEMBERSHIP CORP.
6. TIDE WATER POWER COMPANY.
16. DANVILLE WATER, GAS & ELECTRIC DEPTS.
17. COLUMBUS AND SOUTHERN OHIO ELECTRIC CO.
18. OHIO POWER COMPANY.
19. MONONGAHELA WEST PENN PUBLIC SERVICE CO.
22. PENNSYLVANIA ELECTRIC CO.
23. POTOMAC TRANSMISSION CO.
24. POTOMAC EDISON COMPANY.
25. POTOMAC LIGHT AND POWER CO.
28. POTOMAC ELECTRIC POWER CO.
29. SUSQUEHANNA TRANSMISSION CO. OF MD.
30. CONSOLIDATED GAS, ELECTRIC LIGHT AND POWER CO. OF BALTIMORE.
34. PENNSYLVANIA RAILROAD CO.
36. DELAWARE POWER AND LIGHT CO.
38. ATLANTIC CITY ELECTRIC CO.

LEGEND

- PROPOSED OR ADOPTED FED. MULTIPLE-PURPOSE PROJECTS
- 62.0 EXISTING HYDRO PLANTS
- 23.6 EXISTING STEAM PLANTS
- TRANSMISSION LINES
- INTERCONNECTION BETWEEN NON-AFFILIATED COS.
- INTERCONNECTION BETWEEN AFFILIATED COMPANIES
- JUNCTION LINES
- CROSSOVER
- STATE BOUNDARIES
- LIMITS OF POWER SUPPLY AREAS
- (6) DESIGNATES THE NUMBER OF POWER SUPPLY AREA
- (2) INDEX TO NAMES OF OPERATING COMPANIES

NOTE: FIGURES BY GENERATING STATIONS INDICATE GENERATING CAPACITY AND FIGURES ON TRANSMISSION LINES INDICATE TRANSMISSION CAPACITY.

VIRGINIA STATE PLANNING BOARD
RIVER BASIN COMMITTEE

POWER SUPPLY AREA Nº 18

PRINCIPAL GENERATING AND TRANSMISSION FACILITIES

SEPTEMBER, 1946

SCALE IN MILES
20 0 20 40 60 80

PLATE VIII

TABLE XVIII - ELECTRIC POWER REQUIREMENT - POWER SUPPLY AREA 18

Annual Energy Requirements in Million Kilowatt--Hours							Index-Year 1940 = 100			
Year	Principal Utility Systems	Minor Inter-Connected Utility Systems	Minor Isolated Utility Systems	Total For Utilities	Industrial Generation For Own Use	Total Energy For Load	Total For Utilities	Industrial Generation For Own Use	Total Energy For Load	Total Generation By Utilities Per Cent
1927	546	21	17	584	--	--	42	--	--	--
1928	594	23	19	636	--	--	46	--	--	--
1929	664	28	20	712	--	--	52	--	--	--
1930	709	29	21	759	--	--	55	--	--	--
1931	748	33	22	803	--	--	58	--	--	--
1932	711	32	23	766	--	--	56	--	--	--
1933	708	30	23	761	--	--	55	--	--	--
1934	726	32	25	783	--	--	57	--	--	--
1935	765	35	29	829	--	--	60	--	--	--
1936	866	37	33	936	--	--	68	--	--	--
1937	946	41	37	1024	--	--	74	--	--	--
1938	971	39	39	1049	--	--	76	--	--	--
1939	1117	41	46	1204	721	1925	87	82	85	63
1940	1281	43	52	1376	882	2258	100	100	100	61
1941	1519	44	56	1619	1048	2667	118	119	118	61
1942	1714	46	62	1822	1108	2930	132	126	130	62
1943	1958	50(a)	70(a)	2078	1167	3245	151	132	144	64
1944	2159	50(a)	70(a)	2279	1201(b)	3480	166	136	154	65
1945	2206(c)	50(d)	70(d)	2326	--	--	169	--	--	--
1950	2250(a)	55(d)	74(d)	2379	1840(a)	4219	173	209	187	56
1960	3100(a)	65(d)	81(d)	3246	2210(a)	5456	236	251	242	59
1970	3700(a)	75(d)	88(d)	3863	2510(a)	6373	281	285	282	61

Source: Federal Power Commission, James River Basin Power Market Study, dated May, 1945
Table 19 and Table 46
(a) Estimated by Federal Power Commission
(b) Estimated by Industry
(c) Estimated by Utility
(d) Estimated by River Basin Committee

From the Federal Power Commission's estimates for Power Supply Area 18 it appears that the increase in utility generation is expected to exceed 1940 requirements by 73 per cent in 1950, 136 per cent in 1960, and 181 per cent in 1970. This is approximately 60 per cent for each decade. Industrial requirements will increase at a somewhat faster rate and are expected to exceed 1940 requirements by 109 per cent in 1950, 151 per cent in 1960, and 185 per cent in 1970. The rapid increase between 1940 and 1950 is due to the lag of installation of generating facilities during the war when there was a large expansion of other production facilities. The utilities are expected to retain about the same percent of the power market that they served in 1940 but may temporarily lose some market in the next few years because of the expected increase in industrial power facilities to balance past increase in other production facilities.

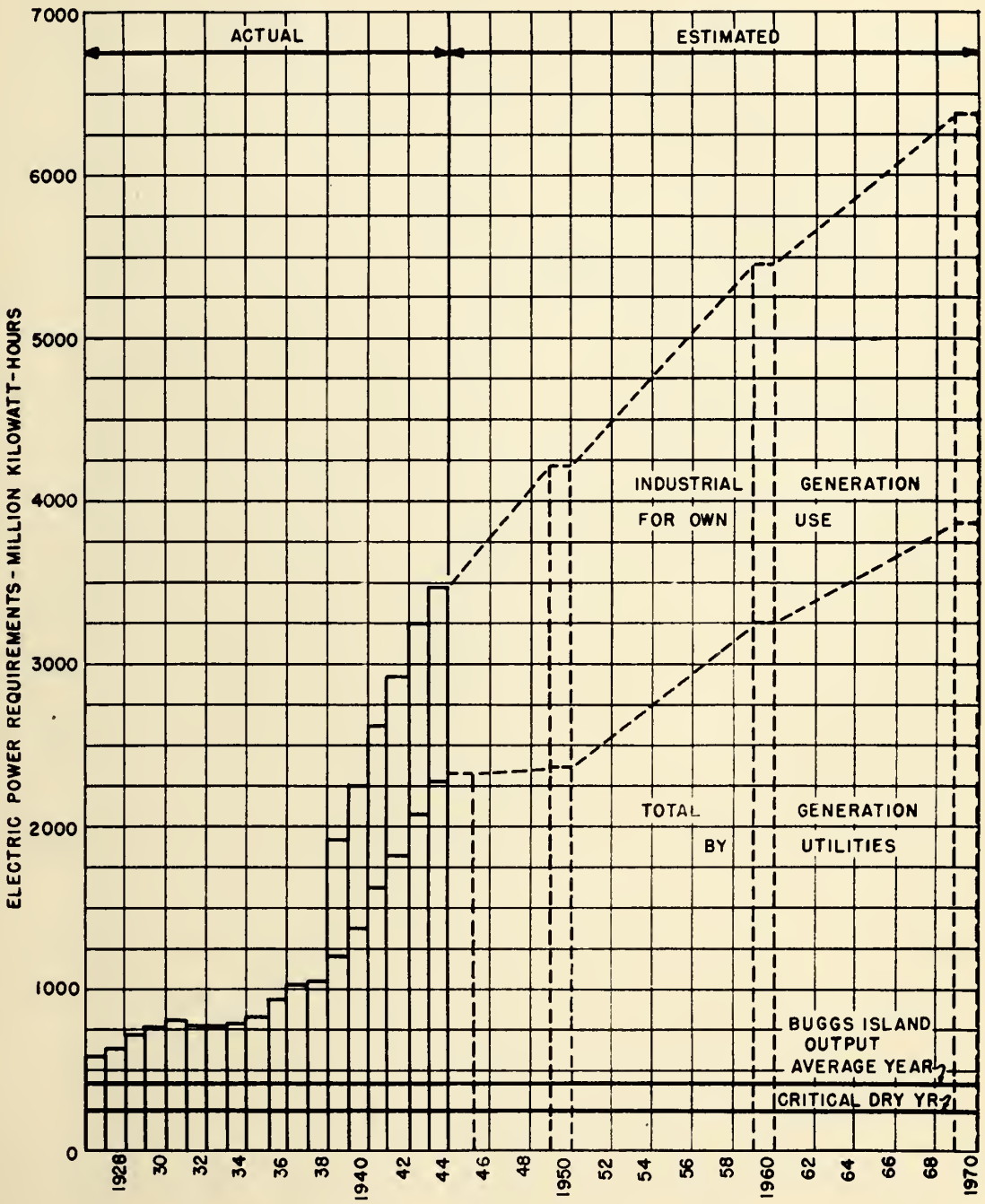
At the end of 1943 the total installed capacity in industrial developments was 227,337 kilowatts of which 218,337 kilowatts was steam electric. These industrial power plants are in most cases installed to supply process steam as well as electrical energy. They usually operate non-condensing and are not suitable for interconnecting with the utility system. These industries are not considered as a market for Buggs Island power and their power production is not competitive with it. For these reasons they will not be discussed further.

Power Supply Area 18 is served almost entirely by the Virginia Electric and Power Company and data compiled by the Federal Power Commission give the details of distribution of electric energy by class of use for that system. These data are shown in Table XIX and Chart XIV by energy use for four classifications; namely, "Residential and Rural", "Commercial and Other", "Industrial" and "Losses, Utility Use, etc." Detailed records by use are available since 1934 and data on total generation since 1927. These last have been previously given in Table XVIII and on Charts XII and XIII. In addition, Table XIX shows the past and estimated future requirements of the system in terms of 1940 generation and these values are plotted on Chart XV. Table XIX also shows the percentage distribution of the load under the foregoing classifications.

The Federal Power Commission estimates that the largest gain in load will be residential and rural use and such use in 1970 will be approximately four times the 1940 figure, while the total energy use will be slightly less than three times the 1940 figure. The rate of increase in commercial and other use will approximately keep pace with that of the total energy. Industrial use will lag behind the total and will only approximately double the 1940 use. This is because it is estimated that industrial development in Power Supply Area 18 from 1940 to 1970 will be at a somewhat slower rate than it was before 1940 and that industrial generation will supply a slightly higher per cent of the total industrial requirements.

From the above figures, and under average conditions, the Buggs Island Development is estimated to generate only 18 per cent of the requirements of the principal utility in 1950, 13 per cent in 1960, and 11 per cent in 1970. In the critical dry year such as 1930-31 the development will generate approximately one half as much as during the average year.

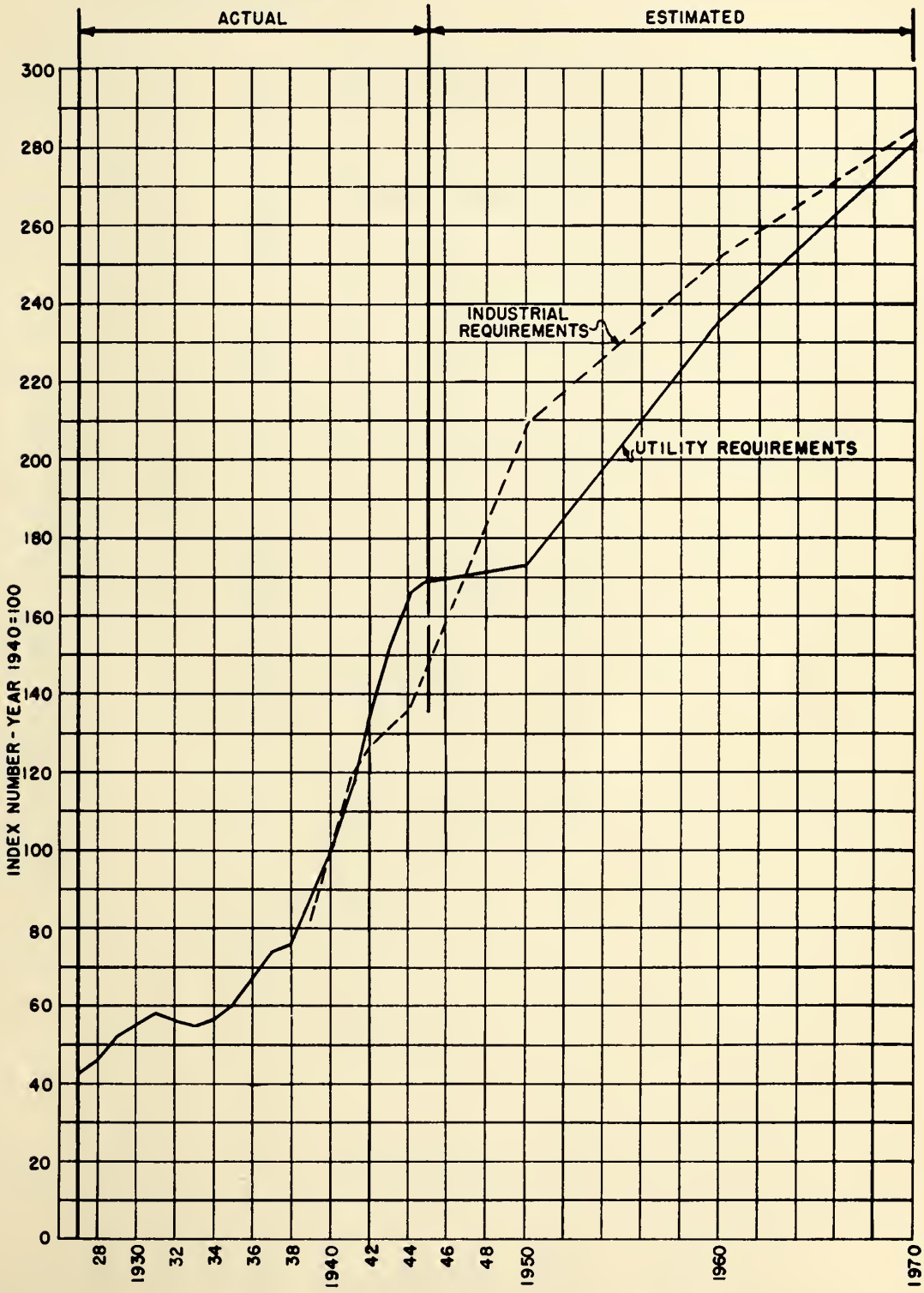
SOURCE-FEDERAL POWER COMMISSION, JAMES RIVER BASIN POWER MARKET STUDY
DATED MAY, 1945.



PAST AND ESTIMATED FUTURE GROWTH OF ELECTRIC POWER REQUIREMENTS BASED ON KILOWATT - HRS. INDUSTRIAL AND UTILITY GENERATION POWER SUPPLY AREA 18

CHART XIII

SOURCE - FEDERAL POWER COMMISSION, JAMES RIVER BASIN POWER MARKET STUDY DATED MAY, 1945.



PAST AND ESTIMATED FUTURE GROWTH OF ELECTRIC POWER REQUIREMENTS BASED ON INDEX NUMBER – 1940 = 100

INDUSTRIAL AND UTILITY GENERATION

POWER SUPPLY AREA 18

TABLE XIX - DISTRIBUTION OF ELECTRIC ENERGY BY CLASS OF USE
PRINCIPAL UTILITY SYSTEM - POWER SUPPLY AREA 18

Year	Annual Energy in Millions of KWH					Index-Year 1940 = 100				Per Cent of Total Net Energy		
	Sales to Ultimate Consumers					Sales to Ultimate Consumers				Sales to Ultimate Consumers		
	Residential and Rural	Commercial and Other (a)	Industrial	Losses Utility Use, Etc.	Total Net Energy for Load	Residential and Rural	Commercial and Other	Industrial	Total Net Energy for Load	Residential and Rural	Commercial and Other	Industrial
1934	129	155	289	153	726	50	45	64	57	18	21	40
1935	146	169	294	156	765	56	49	65	60	19	22	38
1936	169	192	331	174	866	65	56	73	68	20	22	38
1937	191	219	363	173	946	73	64	80	74	20	23	38
1938	217	267	310	177	971	83	78	69	76	22	27	32
1939	234	301	388	194	1117	90	87	86	87	21	27	35
1940	260	344	451	226	1281	100	100	100	100	20	27	35
1941	289	430	531	269	1519	111	125	118	119	19	28	35
1942	318	502	623	271	1714	122	146	138	134	19	29	36
1943	347	648	671	293	1959	133	188	149	153	18	33	34
1944	---	---	---	---	2159	---	---	---	169	--	--	--
1945	---	---	---	---	2206(b)	---	---	---	172	--	--	--
1950	505(c)	635(c)	680(c)	430(c)	2250(c)	194	185	151	176	22	28	30
1960	850(c)	850(c)	820(c)	580(c)	3100(c)	327	247	182	242	27	27	26
1970	1050(c)	1000(c)	950(c)	700(c)	3700(c)	404	291	211	289	28	27	26

Source: Federal Power Commission, James River Basin Power Market Study, Date May, 1945
Table 22, Table 41, Table 44, Table 45, Table 46, Table 47

(a) Includes Energy for Isolated Minor Systems absorbed prior to 1939 and sales to Minor Utilities

(b) Estimated by Utilities

(c) Estimated by Federal Power Commission

The James River Basin Power Market Study of the Federal Power Commission contains data on the maximum demands and the annual load factors for the principal utility system serving Power Supply Area 18. These are given in Table XX.

TABLE XX - MAXIMUM DEMAND AND ANNUAL LOAD FACTORS
PRINCIPAL UTILITY - POWER SUPPLY AREA 18

Year	Coincident Annual Peak Load Thousands of Kilowatts	Load Factor
1939	255	50.0
1940	278	52.5
1941	316	54.9
1942	340	57.5
1943	374	59.6
1944	389	63.2
1945 1/	396	- - -
1950 2/	470	54.6
1960 2/	630	56.2
1970 2/	745	56.7

1/ Estimated by Utility
2/ Estimated by Federal Power Commission

The Federal Power Commission also reports the following generating facilities of the Virginia Electric and Power Company as of December 31, 1944:

Type	Installed Capacity		Dependable Capacity	
	Kilowatts	Per Cent	Kilowatts	Per Cent
Steam-electric	388,000	90	419,000	98
Hydro-electric	44,831	10	10,000	2
Total	432,831	100	429,000	100

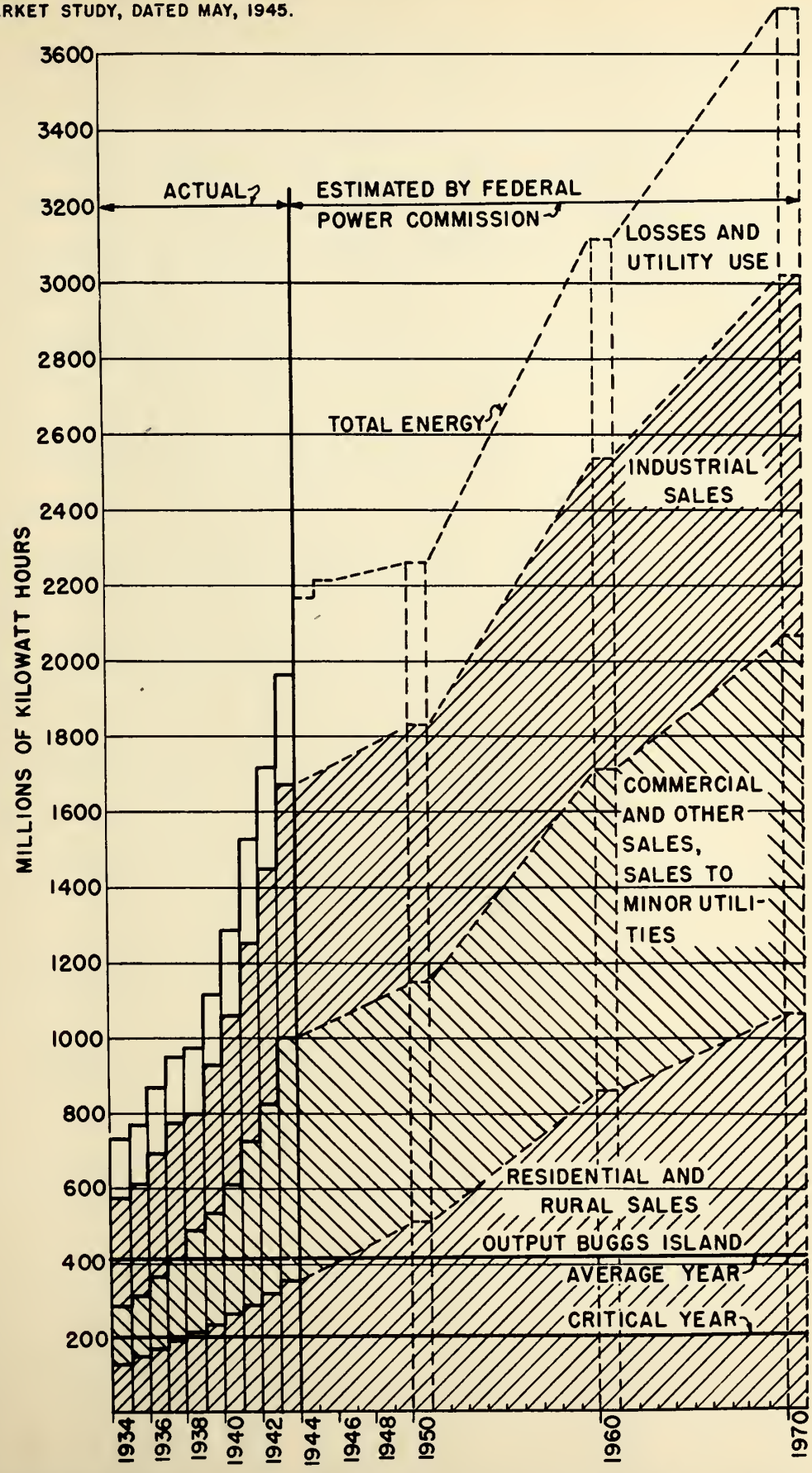
The generation during 1943 by the principal system is reported as:

Steam-electric	1,799,912,000 Kilowatt-hours
Hydro-electric	178,728,000 Kilowatt-hours
Total System Generation	1,978,640,000 Kilowatt-hours

The Buggs Island Project, in the average year, as estimated by the Corps of Engineers could furnish 21 per cent of the 1943 generation of the principal utility.

The Federal Power Commission's report contains the figures given in Table XXI on Capacity-Load for the Virginia Electric and Power Company. It should be noted that if the Virginia Electric and Power Company in 1944 had been forced to meet its maximum demand while maintaining, with its own facilities, the total reserve it reported as required, the utility could not have carried its peak load.

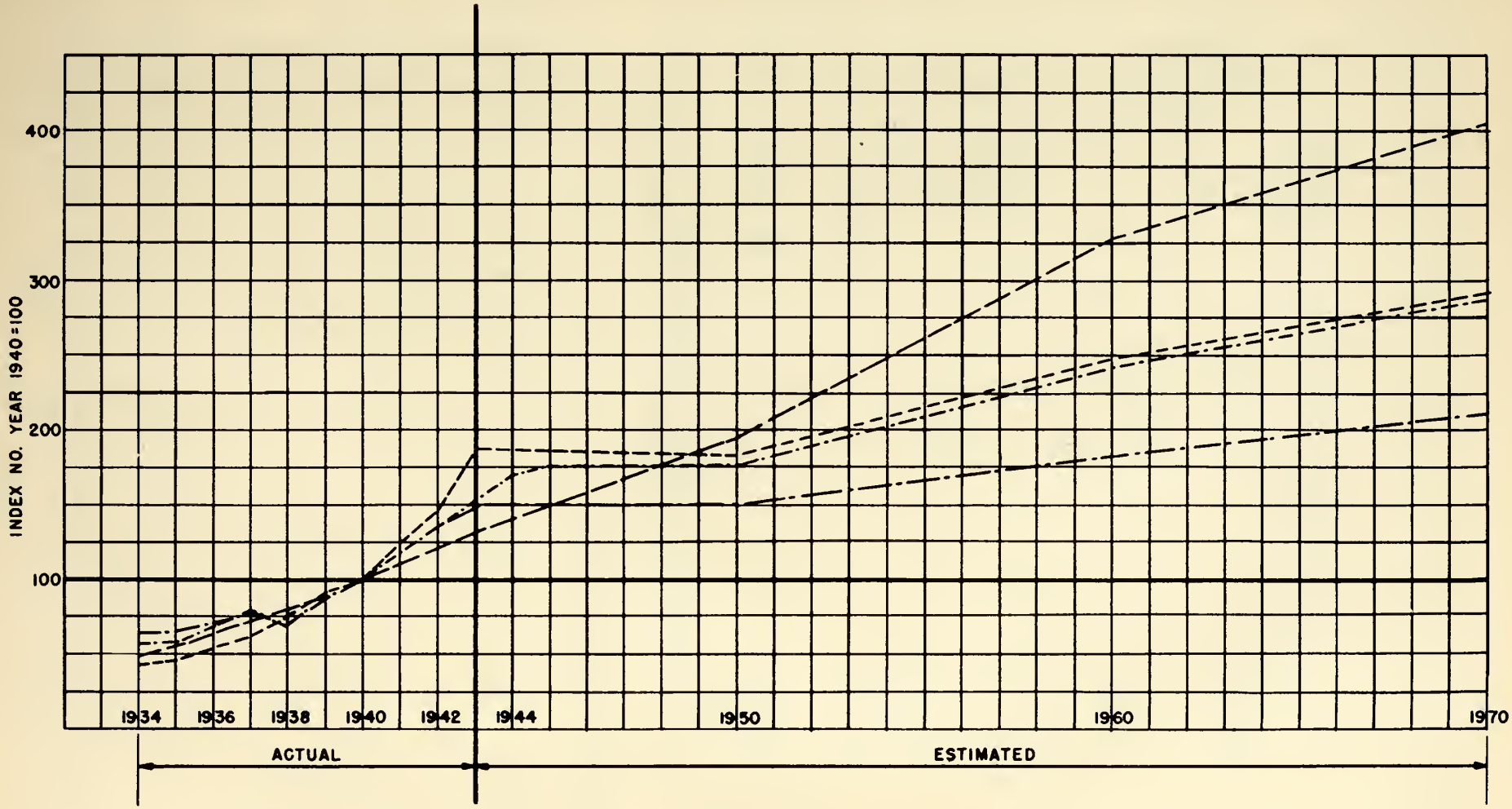
SOURCE: FEDERAL POWER COMMISSION, JAMES RIVER POWER MARKET STUDY, DATED MAY, 1945.



ENERGY REQUIREMENTS AND DISTRIBUTION BASED ON KILOWATT-HOURS

PRINCIPAL UTILITY-POWER SUPPLY AREA 18

SOURCE: FEDERAL POWER COMMISSION
JAMES RIVER POWER MARKET STUDY
DATED MAY, 1945.



LEGEND

- RESIDENTIAL AND RURAL
- COMMERCIAL AND OTHER
- TOTAL FOR LOAD
- INDUSTRIAL

ENERGY REQUIREMENTS AND DISTRIBUTION
BASED ON INDEX NUMBER-1940=100
PRINCIPAL UTILITY - POWER SUPPLY AREA 18

CHART XV

The Federal Power Commission has estimated the additional dependable capacity required to supply the estimated future loads in Power Supply Area 18 for the years 1950, 1960 and 1970. These estimates are given in Table XXII.

TABLE XXI - CAPACITY LOAD DATA
VIRGINIA ELECTRIC AND POWER COMPANY

Item	Kilowatts	Kilowatts
Capacity		
Net Dependable		
Fuel	419,000	
Hydro	10,000	
		429,000
Obligations	1,500	
		(-) 1,500
Required Reserves		
Total Required	59,000	
Reserves from Other Systems	45,000	
Reserves from Own System		(-) 14,000
Net Assured Capacity		413,500
Load		
1944 System Peak		388,700
1945 System Peak (Utility Estimate)		396,000

TABLE XXII - ADDITIONAL DEPENDABLE CAPACITY REQUIRED IN POWER SUPPLY AREA 18

Item	Thousands of Kilowatts		
	1950	1960	1970
Peak Demand	470.0	630.0	745.0
Capacity Allocated for Reserves	60.0	75.0	80.0
Total Capacity Required	530.0	705.0	825.0
Capacity Available for Load			
Existing Steam Capacity (1944)	419.0	419.0	419.0
Retirements of Steam Capacity	7.3	57.0	117.0
Net Steam Capacity	411.7	362.0	302.0
Hydro Capacity	10.0	10.0	10.0
Total Available Capacity	421.7	372.0	312.0
Total Additional Capacity Required	108.3	333.0	513.0

The maximum demands as given in Table XX, the existing dependable capacity and the data contained in Table XXII are plotted on Chart XVI.

The Federal Power Commission estimates retirements of obsolete generating equipment to total 7,300 kilowatts by 1950, 57,000 kilowatts by 1960 and 117,000 kilowatts by 1970. If these retirements are not replaced,

the existing dependable capacity and the required dependable capacity will be equal in 1947. In 1950, the required dependable capacity will exceed that existing by 108,300 kilowatts, in 1960 by 333,000 kilowatts and in 1970 by 513,000 kilowatts.

There is nothing to indicate that the utility will not meet its demand requirements by new construction. It has announced the construction of additional generating facilities at the Reeves Avenue Station, Norfolk, to cost $3,250,000 and a new 60,000 kilowatt station on Quantico Creek near Dumfries, Virginia. These will increase the dependable capacity by approximately 100,000 kilowatts and practically meet the deficiency estimated as likely to exist in 1950.

The Federal Power Commission has computed the value of hydroelectric energy for the Buggs Island Project by comparing it with the cost of steam-electric energy generated at a comparable location. By estimating a fixed capital charge and fixed operating and fuel costs, an annual capacity value per kilowatt was obtained. The variable costs of labor and fuel were then estimated per kilowatt hour of generated energy. Corrections were applied to these values to allow for the additional transmission losses and charges which must be borne by hydroelectric energy and which reduce its value. To these last values corrections were added to allow for the greater dependability of hydroelectric power. The greater dependability of a hydroelectric plant results from the use of slow speed, heavy and rugged equipment. A steam-electric plant employs high speed, less durable machinery which is subjected to high temperatures.

The estimated power values furnished the Corps of Engineers by the Federal Power Commission are as follows:

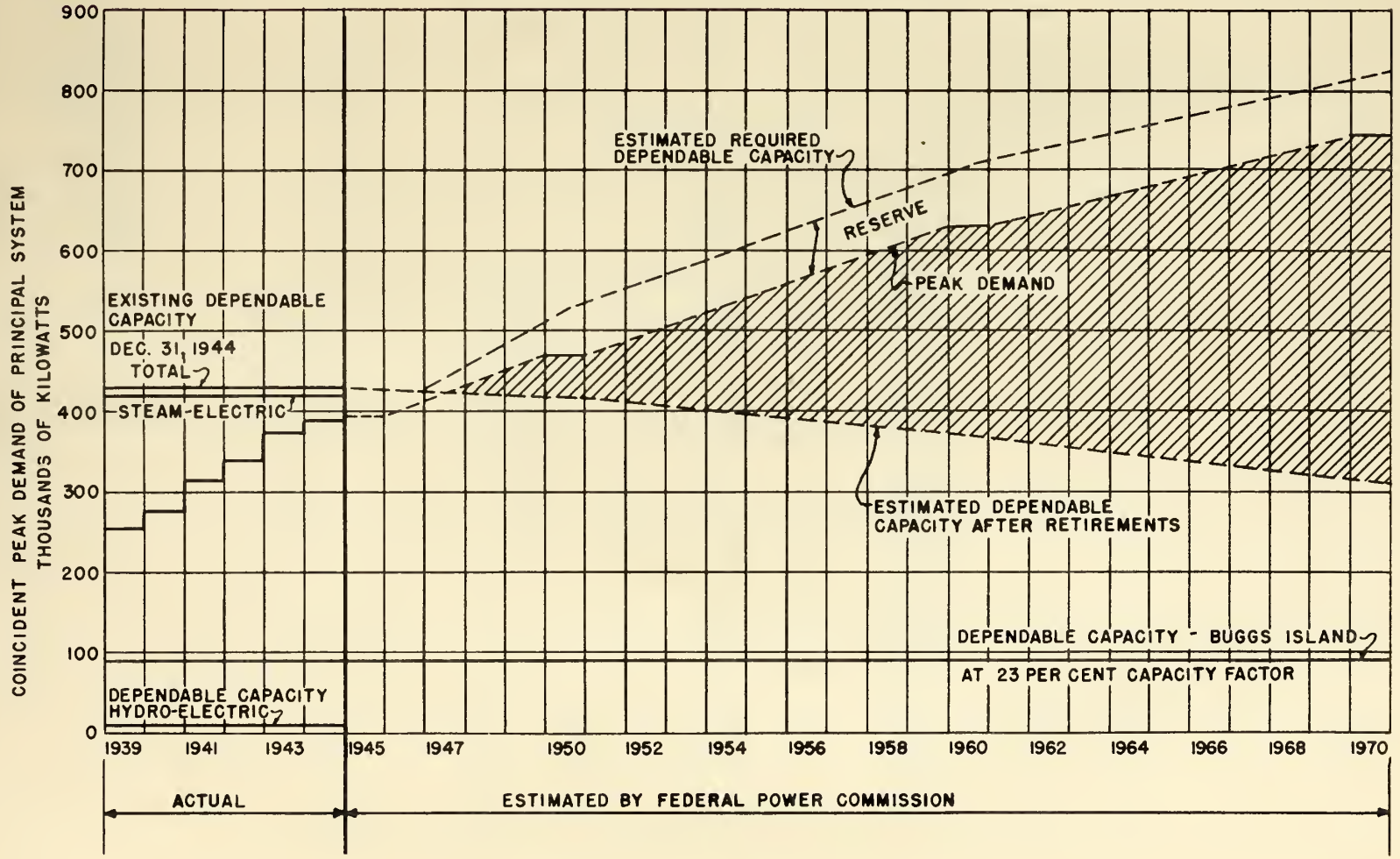
Annual Capacity Value	$15.63 per KW.
Generated Energy	2.22 Mills per KW.-HR.

From these values, the value of the power at the Buggs Island site computed for varying capacity factors is given below:

	Mills per Kilowatt-Hour		
Capacity Factor	Capacity Value	Energy Value	Total Value
100	1.78	2.22	4.00
50	3.57	2.22	5.79
40	4.46	2.22	6.68
30	5.95	2.22	8.17
25	7.14	2.22	9.36
23	7.76	2.22	9.98
20	8.92	2.22	11.14
15	11.89	2.22	14.11

These values are plotted on Chart XVII. This chart also shows cost as given in published rates to industrial users for untransformed energy delivered at line voltage to the customers substation.

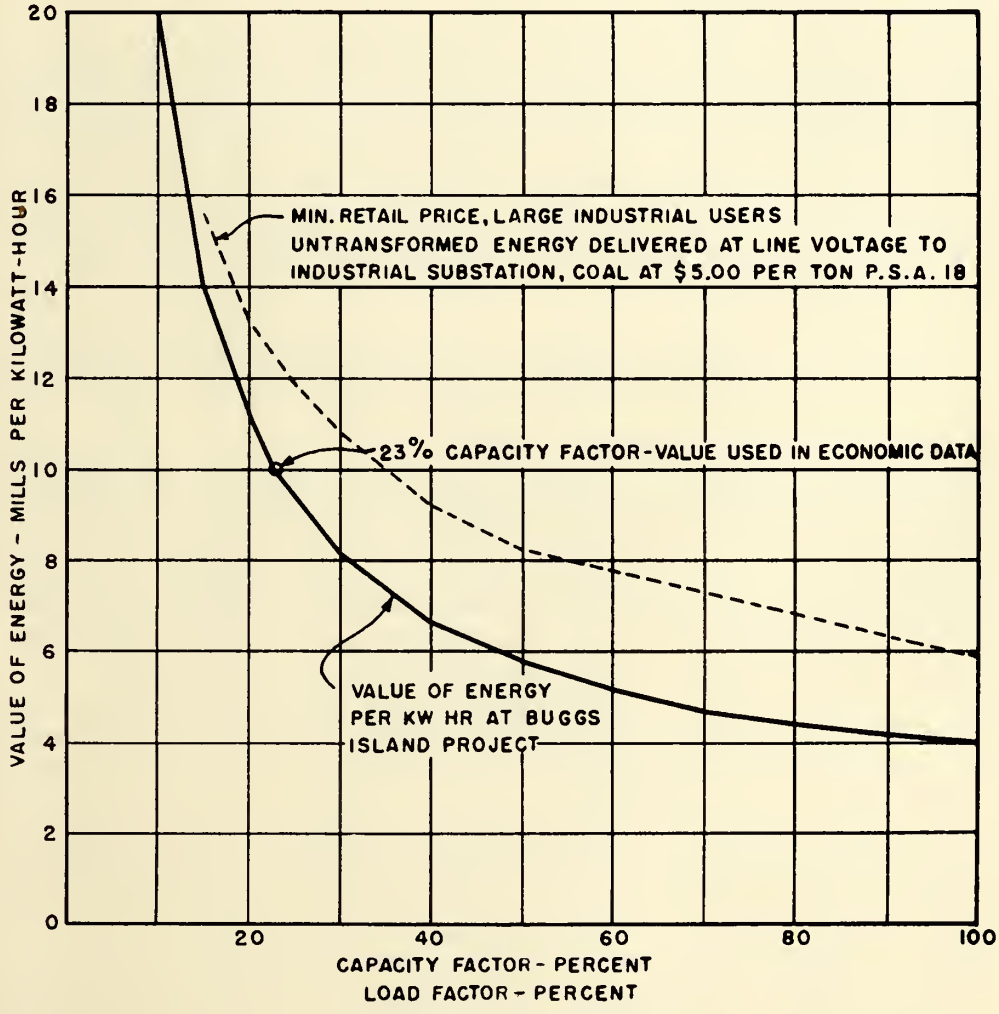
RESERVE IS AS ESTIMATED BY THE FEDERAL POWER COMMISSION AS NEEDED IN EXCESS OF PEAK DEMAND TO CARE FOR SCHEDULED AND UNSCHEDULED OUTAGES, UNPLANNED FOR LOAD, ETC. TO ASSURE CONTINUITY OF SERVICE.



PEAK DEMAND
PRINCIPAL UTILITY - POWER SUPPLY AREA 18

SOURCE: FEDERAL POWER COMMISSION
JAMES RIVER BASIN POWER MARKET
STUDY DATED MAY, 1945.

CHART XVI



SOURCE- FEDERAL POWER COMMISSION
CAPACITY VALUE - $15.63 PER KW YEAR
ENERGY VALUE - 2.22 MILLS PER KW HR.

VALUE OF POWER AT SITE
BUGGS ISLAND DEVELOPMENT

The Federal Power Commission placed the Buggs Island Project on the load at the most advantageous position after making allowance for other Federal power plants planned in the competitive area. This resulted in planning to operate the plant at 23 per cent capacity factor. The dependable capacity of the plant at a 23 per cent capacity factor is 90,000 kilowatts and the generation at an appropriate capacity factor is estimated as 410,000,000 kilowatt-hours during the average year. The annual benefits for power at the site were estimated as follows:

$15.63 x 90,000	=	$1,406,700
0.00222 x 410,000,000	=	910,200
		$2,316,900

This does not indicate that energy will be sold to realize $2,316,900 in the average year but gives the value placed on it as compared with alternative steam-electric energy. To realize this amount, the energy must be sold at an average price of 5.6 mills per kilowatt-hour. This could hardly be classed as "cheap power" but does appear to be competitive with energy from an alternative source. In the drought year, 90,000 kilowatts can be supplied for only 23 per cent of the time. An additional source of energy must be available to purchasers requiring a continuous supply of power.

The disposal of the Buggs Island power is governed by Section 5 of the act authorizing the development, and reads as follows:

> "Sec. 5. Electric power and energy generated at reservoir projects under the control of the War Department and in the opinion of the Secretary of War not required in the operation of such projects shall be delivered to the Secretary of the Interior, who shall transmit and dispose of such power and energy in such manner as to encourage the most widespread use thereof at the lowest possible rates to consumers consistent with sound business principles, the rate schedules to become effective upon confirmation and approval by the Federal Power Commission. Rate schedules shall be drawn having regard to the recovery (upon the basis of the application of such rate schedules to the capacity of the electric facilities of the projects) of the cost of producing and transmitting such electric energy, including the amortization of the capital investment allocated to power over a reasonable period of years. Preference in the sale of such power and energy shall be given to public bodies and cooperatives. The Secretary of the Interior is authorized, from funds to be appropriated by the Congress, to construct or acquire, by purchase or other agreement, only such transmission lines and related facilities as may be necessary in order to make the power and energy generated at said projects available in wholesale quantities for sale on fair and reasonable terms and conditions to facilities owned by the Federal Government, public bodies, cooperatives, and privately owned companies. All moneys received from such sales shall be deposited in the Treasury of the United States as miscellaneous receipts."

As regards a market for the Buggs Island power, the Review Report of the Corps of Engineers stated that "The economic extent to which Roanoke River hydro power can be absorbed by an expanding market is almost entire-

ly dependent upon price. If the existing power companies can buy power more cheaply than they can produce it, it would, of course, be advantageous to do so. On the other hand, if new generating stations, either steam or hydro, can be built by the utilities to produce at a rate lower than the best purchase price, then it is reasonable to suppose that new stations will be added to the existing systems. Whether these additions are hydro or steam stations will depend upon their comparative effect upon the economics of the given utility system. In any case, because of lower anticipated return on investment, certain tax exemptions, amortization requirement, and multiple-purpose features of reservoir operation, federal hydro systems can generally produce power at a lower rate than comparative private hydro projects."

The Federal Power Commission states that "Electric rates are somewhat lower in the study area than in the United States as a whole for commercial power and are approximately equal for commercial light, while residential service, other than for lighting alone is somewhat more expensive." The study area of the report on the James River Basin embraced Power Supply Areas 10 and 18 and, since the rates in Area 18 are as high or higher than in Area 10 except for commercial power, the above statement holds true for Power Supply Area 18. The Federal Power Commission made no such comparison of industrial power as most of it is sold under special contracts and the use of data from standard tariffs might lead to erroneous conclusions. Cost of power is usually not the most important item determining the location of industry. Except for the electric-process industries, availability and cost of raw materials; availability, skill and cost of labor; accessibility to markets; transportation facilities; and management factors influence location of new plants more than does the cost of electric service. The amount of electric energy used for residential and commercial purposes is more directly connected to the cost and in these classes rates in Power Supply Area 18 are somewhat higher than the average for the United States.

In order to have sufficient value to make the project self-liquidating, the power from the Buggs Island Development must serve the relatively low load factor portion of the energy requirements. This means that the plant will carry the peak loads that occur when high demand exists. Demand varies during the day, being highest in the morning and afternoon; during the week, being lowest on Sunday; and during the year, being highest in December and lowest in the summer. Therefore all of the installed and operative generating equipment is not called on to generate continuously. This available capacity does not bring in revenue when not operating and therefore the fixed cost per kilowatt hour generated is higher than if it operated continuously. This energy is therefore valued higher than that which is demanded continuously. In evaluating the Buggs Island Project, it was placed on the power requirements diagram to operate only a portion of the time. If the Buggs Island Project generated continously, it would have a primary capacity of 23,000 kilowatts. When placing the plant on the load at a 23 per cent capacity factor, the primary capacity is reduced to 20,700 kilowatts because of the releases necessary to meet flow requirements, principally because of the need of flows during the striped bass spawning period and during the hot summer months when sewage dilution demands are greatest. The plant then has a dependable capacity of 90,000 kilowatts at a 23 per cent capacity factor. In a critically dry year, under the proposed schedule of operation, it can supply 90,000 kilowatts for less than one quarter of the time and would be shut down and storing water for 77 per cent of the time or operating at a much smaller out-put.

In order to realize the benefits claimed, the Buggs Island power must be marketed through an integrated system which has other generating facilities to carry the remainder of the load. This market will be found to a large extent in Power Supply Area 18. Power Supply Area 21, which lies to the southwest of the Buggs Island Project has a number of large capacity hydroelectric installations in its western portion. In plentiful water years, the eastern portion of Power Supply Area 21 can be served by the excess power produced at the Buggs Island Project as fuel saving energy and to avoid transmission losses. In dry years, any output in excess of that required in Power Supply Area 18 could also be absorbed in the eastern portion of Power Supply Area 21 as fuel saving energy. In the future, the demand in Power Supply Area 21 will expand with the development of the area and be a market for additional Roanoke River power. When available, energy could also be sent through the Henderson, N. C., sub-station in the reverse direction to that sent during the war from Power Supply Area 10 to serve the aluminum industry.

Chart XVIII shows generalized load diagrams of Power Supply Area 18 derived from the estimates of annual energy requirements and maximum demands as given by the Federal Power Commission. These diagrams were prepared after deducting the "required" reserves and the estimated retirements from the existing dependable capacity. On these have been superimposed the energy and dependable capacity of the Buggs Island Development. These diagrams indicate there will be some overlap of the output of the existing steam-electric generating stations and the Buggs Island Plant in 1950. The dependable capacity at 23 per cent capacity factor is needed but the load allows the generation of only 121,000,000 kilowatt-hours annually in excess of the energy that can be generated by existing installations. If the planned additions of the utility company are in operation by 1950, its generating equipment can take care of both the capacity requirements and the energy requirements.

By 1960, the estimated requirements for generating capacity including reserve total 705,000 kilowatts. This will exceed the existing capacity less retirements by 333,000 kilowatts. If the planned additions of the principal utility and Buggs Island are both in operation, a deficiency of 125,000 kilowatts of capacity will still remain. During the critically dry years all of the energy that Buggs Island can generate at a 23 per cent capacity factor can be taken into the system along with that generated by the principal utility with its existing facilities and its planned additions. During the average year, some of Buggs Island energy will not have a place on the requirements curve, although there is additional energy required at a lower load factor. This energy could be supplied by Buggs Island, if the installed generating capacity is increased to 204,000 kilowatts. The plant could then generate the estimated 410,000,000 kilowatt-hours annually at 23 per cent capacity factor. Generating facilities of 204,000 kilowatts are planned for the ultimate installation.

If the load growth is as estimated by the Federal Power Commission, in 1970 the enlarged system can take the entire output of Buggs Island at the scheduled 23 per cent capacity if the ultimate installation has been made or at 43 per cent capacity factor with the initial installation.

The initial installation calls for one unit of 12,000 kilowatts. The purpose of this unit is not indicated. If there is some small generating equip-

ment installed by the Electric Cooperatives or other publicly owned distribution systems, it is possible that these can be served directly by the Buggs Island Development. By operating this 12,000 kilowatt unit at approximately half load, the plant could supply 6,000 kilowatts continuously but at a reduced efficiency. If the project is to be self-liquidating, such energy would have to be sold at a price not less than that commanded by energy marketed at 23 per cent capacity factor.

For the year ending June 30, 1945, the Rural Electrification Administration reports that the Rural Electric Cooperatives in the entire State of Virginia served 27,641 consumers who were billed with 31,704,000 kilowatt-hours. Annual use per customer averaged 1,147 kilowatt-hours against a nation-wide use of 1,604 kilowatt-hours. Price per kilowatt-hour averaged 4.4 cents as compared with a nation-wide average of 3.3 cents. The Virginia Cooperatives purchased 26,716,000 kilowatt-hours and generated 13,255,000 kilowatt-hours. Their own use and losses totaled 8,267,000 kilowatt-hours or 21 per cent. Their purchases were only 13 per cent of the amount estimated to be generated at Buggs Island in the critically dry year and 7 per cent in the average year.

ECONOMIC DATA - The Corps of Engineers in "Pertinent Data", dated March 13, 1946, has supplied the following economic data on the Buggs Island Project:

INITIAL FEDERAL COSTS

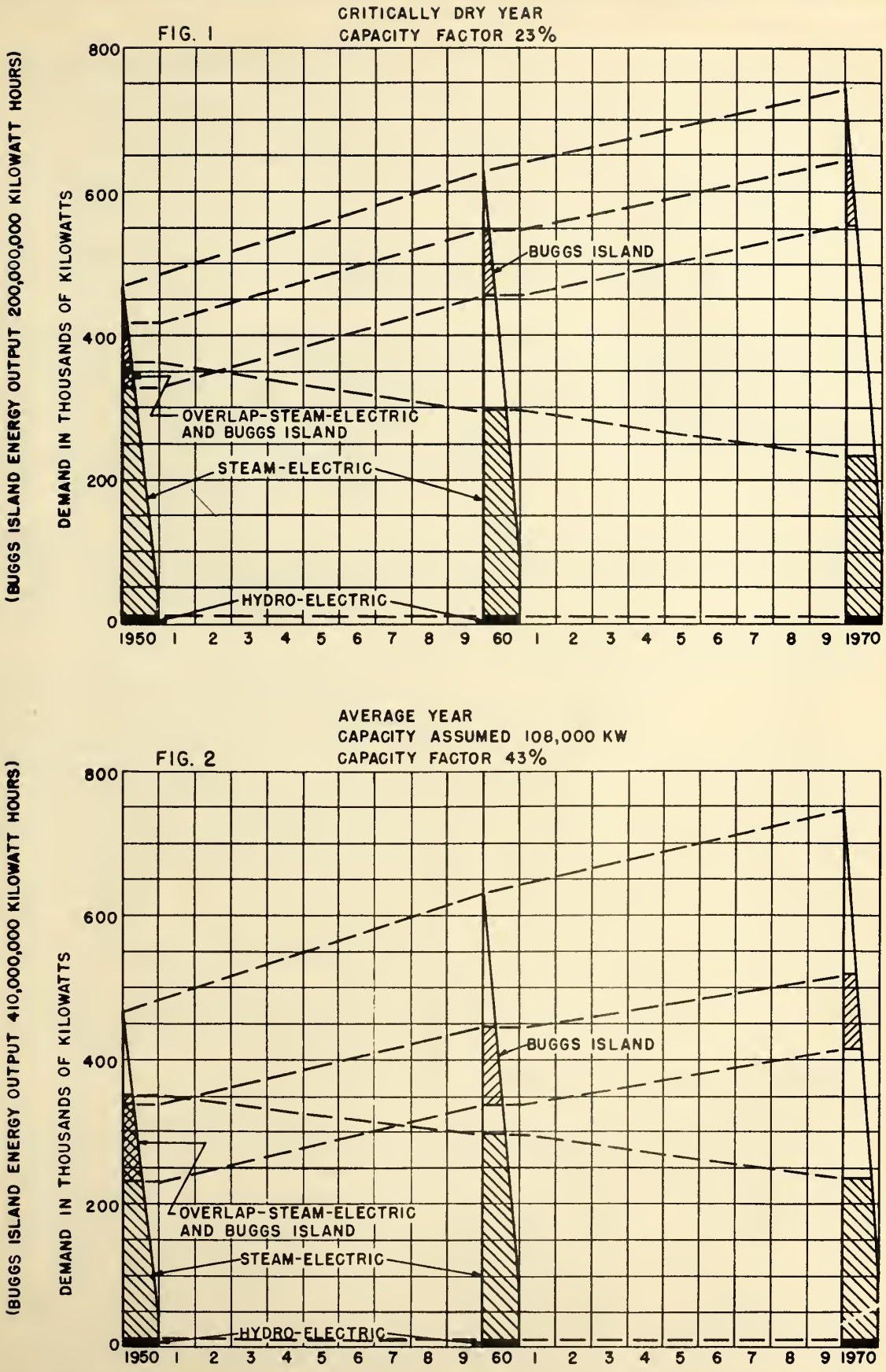
Dam and Appurtenances	$15,020,000
Estimated Flowage Cost	
Reservoir Clearing, Land, and Buildings	10,010,000
Alteration to Railroads, Highways and Utilities	9,610,000
Powerhouse, Switchyard, and Auxiliary Equipment	9,940,000
Preparation of Engineering Designs, Plans and Specifications	1,320,000
Total Estimated First Cost	$45,900,000
Interest During Construction	2,070,000
Total Estimated Federal Investment	$47,970,000

ANNUAL FEDERAL CARRYING CHARGES

Interest at 3%	$ 1,439,000
Amortization at 1.15%	552,000
Maintenance and Operation	204,000
Malaria Control	100,000
Federal Annual Carrying Charges	$ 2,295,000

ANNUAL BENEFITS

From Power at Site	$ 2,320,000
From Increased Capacity Value to Downstream Existing Hydro Plant	30,000



GENERALIZED LOAD DIAGRAMS OF ENERGY REQUIREMENTS
POWER SUPPLY AREA 18

ANNUAL BENEFITS (Con't.)

From Flood Control	$ 267,000
From Rentals from Cleared Land and Timber Sales above Maximum Power Pool	41,000
Total Annual Benefits	$ 2,658,000

ECONOMIC RATIO (Annual Charges to Annual Evaluated Benefits) 1 to 1.16

The large storage capacity of Buggs Island Reservoir will greatly increase the value of the two down-river sites, namely Gaston and Roanoke Rapids, as power generating installations. The minimum natural flow of record at Buggs Island is 467 cubic feet per second. The estimated average for power during the critical low water period will be 4,050 cubic feet per second. With a properly designed installation this increased low water flow can be utilized for power generation.

The River Basin Committee estimates that the Gaston and Roanoke Rapids Projects, as presently planned, would produce energy in such quantities and of such values as given below.

	Gaston	Roanoke Rapids
Primary Capacity, net, Kilowatts	22,400	23,200
Dependable Capacity at 50% Capacity Factor, Kilowatts	44,800	46,400
Annual Energy Output		
Minimum, Million Kilowatt-Hours	196.0	203.2
Average, Million Kilowatt-Hours	327.4	362.4
Value of Capacity at $15.63 per Kilowatt	$ 700,200	$ 725,200
Value of Energy at 2.22 Mills per Kilowatt-Hour	726,800	804,500
Total Average Annual Benefits	$1,427,000	$1,529,700

The cost of these projects was estimated by the Corps of Engineers in the Review Report as follows:

	Gaston	Roanoke Rapids
ESTIMATED INVESTMENT		
Dam and Appurtenances	$ 5,060,000	$ 6,750,000
Reservoir, Clearing, Land, Etc.	2,100,000	660,000
Alterations, etc.	450,000	710,000
Powerhouse, Switchyard, etc.	5,460,000	4,690,000
Total First Cost	$13,070,000	$12,810,000
Interest During Construction	370,000	360,000
Total Estimated Investment	$13,440,000	$13,170,000

	Gaston	Roanoke Rapids
ANNUAL CHARGES		
Interest	$ 379,200	$ 359,100
Amortization	151,700	143,600
Operation and Maintenance	70,300	68,500
Total Annual Charges	$ 601,200	$ 571,200
ANNUAL BENEFITS	$1,390,700	$1,481,600
Excess of Annual Benefits over Annual Charges	789,500	910,400
ECONOMIC RATIO	1 to 2.32	1 to 2.60

The value given above for annual charges does not include step-up transformers and switchyard. The annual benefits represent the value of the power at generator voltage. These estimates of cost as well as the value of power are based on indices of cost which existed at the time of preparation of the Review Report. More detailed engineering study and revision of cost estimates in order to reflect present conditions resulted in a lowering of the economic ratio for the Buggs Island Project. It is likely that a new study of the Gaston and Roanoke Rapids Projects would likewise lower their economic ratios. The restudy of the Buggs Island Project increased the flood protection furnished by the project which partly accounts for the increase in costs. As the Gaston and Roanoke Rapids Projects give no flood protection, any increase in costs must be balanced by an increase in value of steam-electric energy. The capital investment per kilowatt of capacity is usually larger for hydroelectric developments than for steam-electric plants. Therefore the present high construction costs will probably increase the annual charges more than they have increased the annual benefits from steam-electric plants. From this it follows that the economic ratio for the Gaston and Roanoke Rapids Projects will be decreased.

PHILPOTT NO. 4 PROJECT
(Data from the Review Report, Corps of Engineers)

LOCATION AND DESCRIPTION - The dam site is located on the Smith River, which separates Henry and Franklin Counties, Va., and is 44.3 miles above the mouth of the river, 7.0 miles above Bassett, Va., and 3.4 miles above the mouth of Town Creek. The railroad station of Philpott, Va., on the Norfolk and Western Railway, Winston-Salem Division, is located at the confluence of Town Creek and Smith River. The drainage area above the dam is 212 square miles, which is 84 per cent of that above Bassett, Va., 57 per cent of that above Martinsville, Va., and 39 per cent of that above Spray, N. C., where the Smith River joins the Dan. The dam will be a rolled-earth embankment with a diversion tunnel located in the right abutment. A saddle spillway will be located in the left abutment ridge. The power house will be approximately two miles below the dam and will be connected with the reservoir by a tunnel through the left abutment ridge. The Corps of Engineers has begun a restudy of the design of the project and are now considering a concrete dam with the power house immediately below. If this design is adopted the power and diversion tunnels will not be constructed. Details of this revised design are given later in this report.

The principal dimensions of the dam are as follows:*

Length--	
Earth Embankment	945 ft.
Spillway (Ungated)	130 ft.
Diversion and Outlet Tunnel (24 ft. - Inside Diameter)	1,750 ft.
Power Tunnel and Penstock (10 ft. - Inside Diameter)	1,050 ft.
Maximum Height - Earth Embankment--	214 ft.
Maximum Width at Base (Approximate)--	1,300 ft.
Elevations in terms of mean sea level--	
Crest of Earth Embankment	1,020
Flood Plain (general elevation)	820
Base of Dam, Lowest (Approximate)	806
Crest of Spillway	995
Maximum Flood Control Pool	1,013
Maximum Power Pool	986
Minimum Power Pool	925

*See revised details as given later in this report.

The power installation will consist of two generators of 4,500 kilowatts each, driven by two Francis type, vertical shaft hydraulic turbines which will develop 6,400 horsepower at 165 foot head.

The water capacity of the plant is 759 cubic feet per second. The estimated annual output is 22,400,000 kilowatt-hours of primary energy and 1,200,000 kilowatt-hours of secondary energy.

The reservoir at spillway crest elevation of 995 will inundate 3,900 acres in Franklin, Henry, and Patrick Counties, Va. Plate IX shows the reservoir and the surrounding territory. The reservoir at maximum power pool elevation will extend up Smith River about six miles above the mouth of Runnett Bag Creek.

Data pertinent to the reservoir are given below:

Storage (Flat Pool Assumption)--	
Total Volume at Elevation 1,013	317,000 acre-feet
Uncontrolled Flood Storage (Elev. 1,013 to 995)	77,000 acre-feet
Controlled Flood Storage (Elev. 995 to 986)	34,000 acre-feet
Power Storage (Elev. 986 to 925)	133,500 acre-feet
Storage Reserved for Low Water Regulation	6,600 acre-feet
Unusable Storage	65,900 acre-feet
Reservoir Surface (Flat Pool Assumption)--	
To Crest of Spillway (Elev. 995)	3,900 acres
To Maximum Power Pool (Elev. 986)	3,400 acres
To Minimum Power Pool (Elev. 925)	1,450 acres
Lands and Acquisitions--	
Property to be Acquired (Approximate)	4,300 acres
Cleared Area to Maximum Power Pool (Elev. 986)	1,000 acres
Urban Areas Affected	None
Schools Affected	None

Alterations and Relocations--	
Highways	
Primary	None
Secondary	0.75 miles
Railroads	None
Transmission and Distribution Lines	None
Telegraph Lines	None
Cemeteries, approx., number graves	None
Grist Mills, number, alteration	1
State Parks, number, alteration	1

The Philpott No. 4 Projects is being restudied by the Corps of Engineers. The new design is pictured on the frontpiece and will consist of a gravity concrete dam with an ungated spillway section. The power house will be located at the dam and connected to the reservoir by short penstocks. If this design is adopted, the crest of the spillway will be at the approximate elevation of 985 or ten feet lower than that selected for the preliminary design. Such detailed data on the revised design as is now available are presented at the end of this section.

Both designs will require several secondary roads to be abandoned but because of the sparse settlement of the area, the inconvenience will not be great. The area to be inundated is approximately 70 per cent wooded. There is very little merchantable timber in the wooded area.

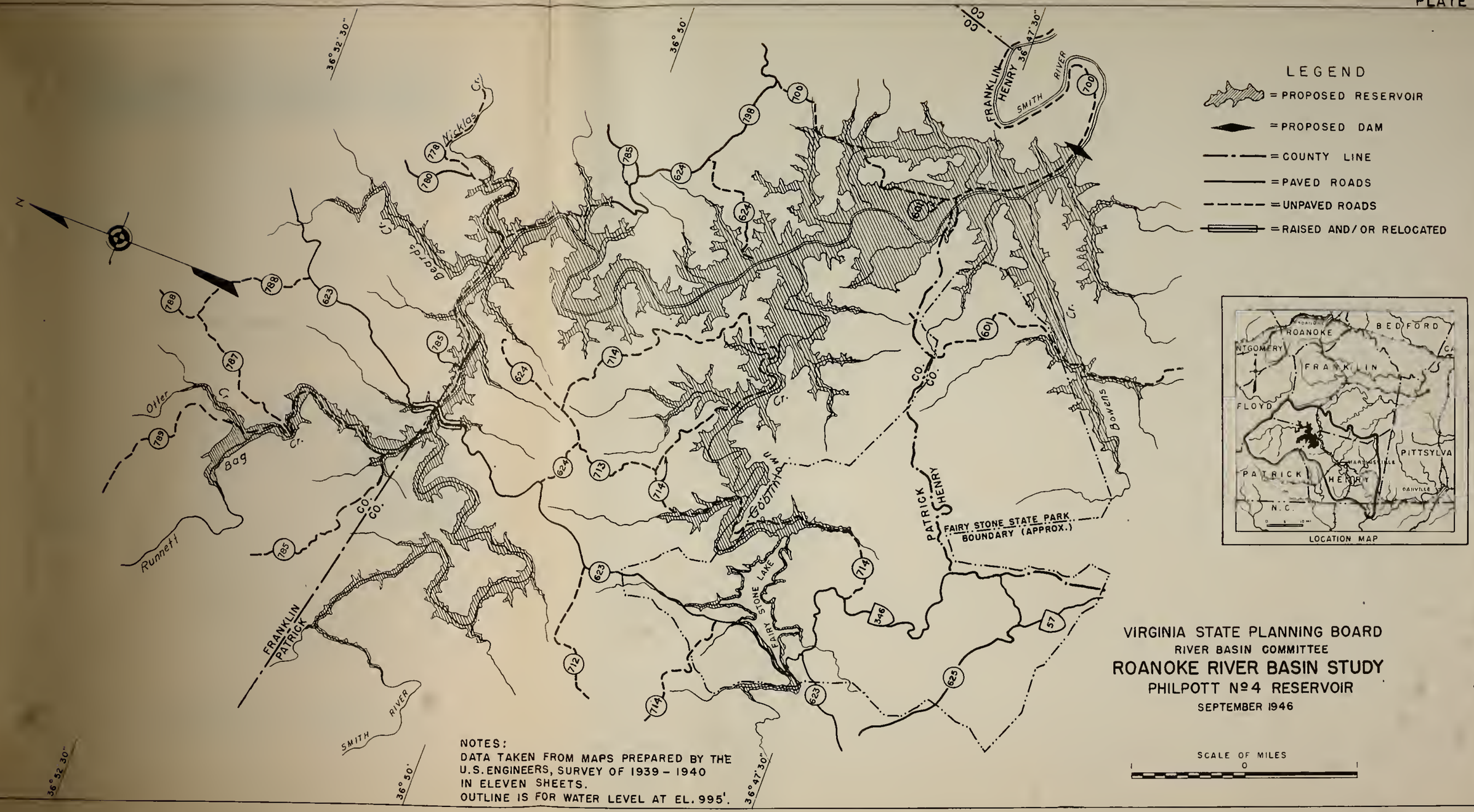
The storage uses are shown graphically on Chart XIX.

FLOOD LOSSES AND BENEFITS - A general discussion of the problems involved in the establishment of an estimate of annual flood losses is included in the section on the Buggs Island Development, page 84, and for the sake of brevity will not be repeated here.

For the purpose of flood loss studies the Smith River was divided into three reaches which were established as damage zones. These are shown on Chart XX. Since damage to crops is minor in the Smith River Valley, the methods used in evaluating such losses were not as refined as in the case of the lower Roanoke River Valley.

The result of these studies for the damage zones of the Smith River is given in the Review Report of the Corps of Engineers in a table, "Estimated Average Annual Flood Damages." The following quotation of the average annual flood damages for Zones S1, S2 and S3 is an excerpt from this table.

Zone No.	From	To	Annual Flood Damages			
			To Crops and Farm Improvements	To All Other Developments	Total	Per Cent of Basin
S1	Philpott	Fieldale	$1,900	$100,100	$102,000	19.4
S2	Fieldale	Leatherwood Ck.	1,800	31,800	33,600	6.4
S3	Leatherwood Ck.	Mouth	3,800	14,900	18,700	3.6
	Total		$7,500	$146,800	$154,300	29.4
	Total for Roanoke River Basin				$524,800	100.0



NOTES:
DATA TAKEN FROM MAPS PREPARED BY THE U.S. ENGINEERS, SURVEY OF 1939 – 1940 IN ELEVEN SHEETS.
OUTLINE IS FOR WATER LEVEL AT EL. 995'.

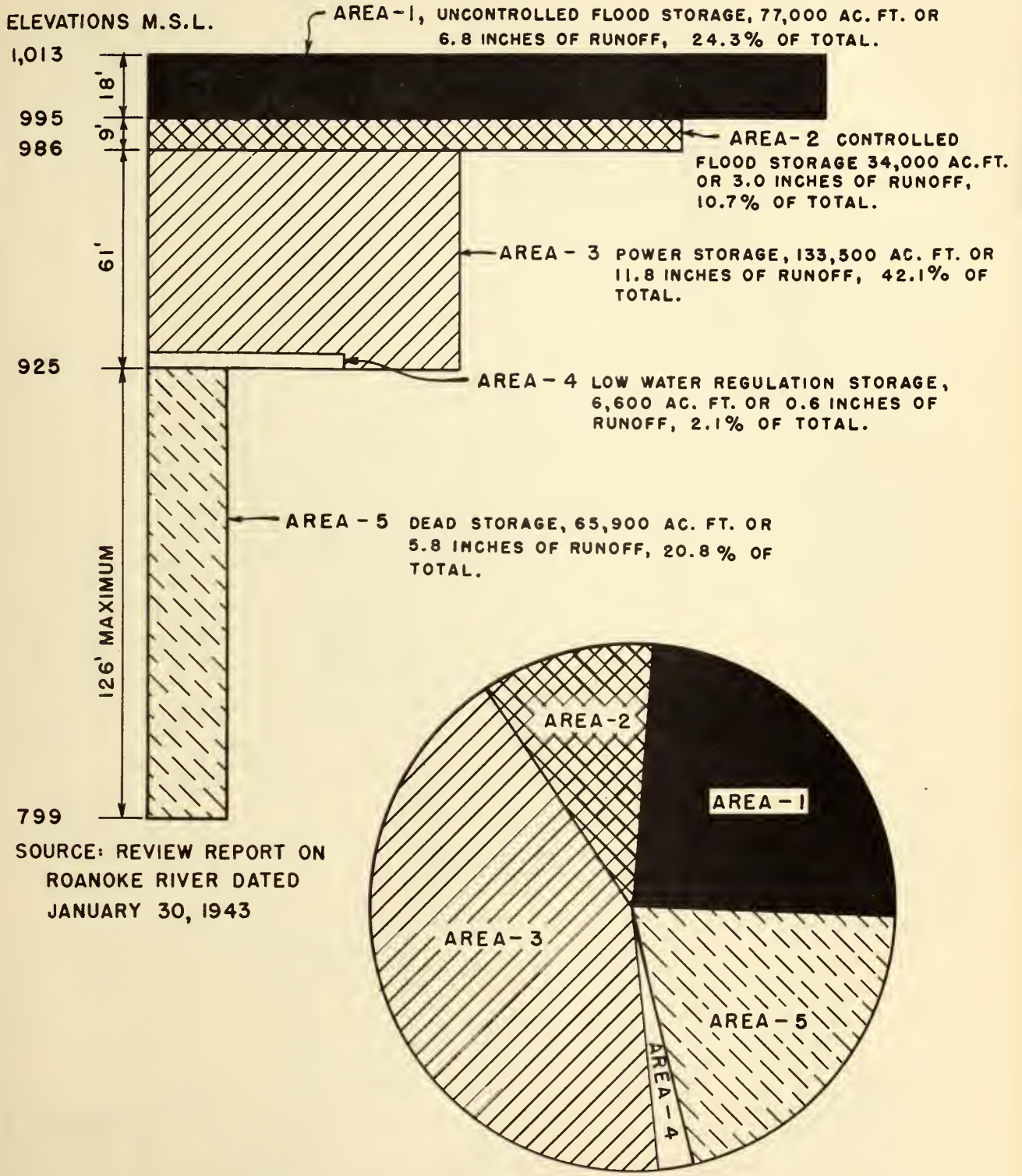
VIRGINIA STATE PLANNING BOARD
RIVER BASIN COMMITTEE

ROANOKE RIVER BASIN STUDY

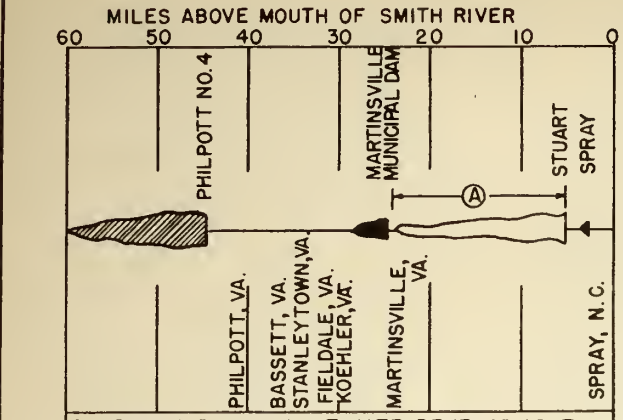
PHILPOTT Nº 4 RESERVOIR

SEPTEMBER 1946

SCALE OF MILES
0


ELEVATIONS M.S.L.
AREA-1, UNCONTROLLED FLOOD STORAGE, 77,000 AC. FT. OR 6.8 INCHES OF RUNOFF, 24.3% OF TOTAL.
1,013
18'
995
9'
986
AREA-2 CONTROLLED FLOOD STORAGE 34,000 AC.FT. OR 3.0 INCHES OF RUNOFF, 10.7% OF TOTAL.
61'
AREA-3 POWER STORAGE, 133,500 AC. FT. OR 11.8 INCHES OF RUNOFF, 42.1% OF TOTAL.
925
AREA-4 LOW WATER REGULATION STORAGE, 6,600 AC. FT. OR 0.6 INCHES OF RUNOFF, 2.1% OF TOTAL.
AREA-5 DEAD STORAGE, 65,900 AC. FT. OR 5.8 INCHES OF RUNOFF, 20.8% OF TOTAL.
126' MAXIMUM
799
SOURCE: REVIEW REPORT ON ROANOKE RIVER DATED JANUARY 30, 1943
AREA-2
AREA-1
AREA-3
AREA-5
AREA-4

STORAGE VOLUMES
PHILPOTT Nº 4 RESERVOIR



SCHEMATIC PLAN OF ULTIMATE DEVELOPMENT

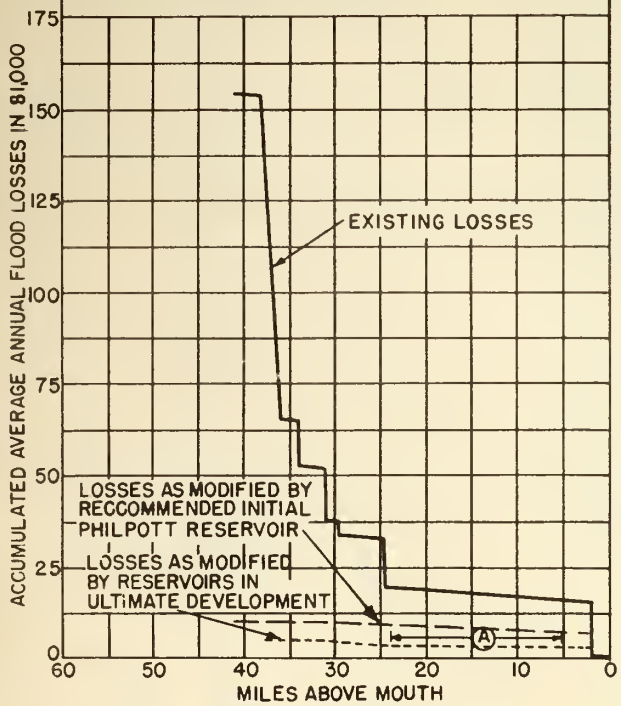
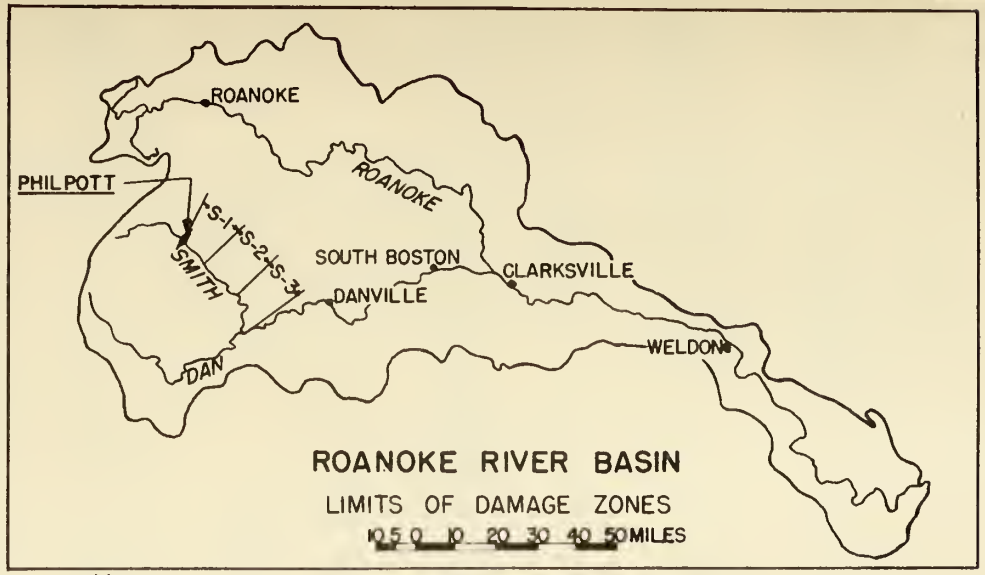


FIGURE NO. 1 **SMITH RIVER**

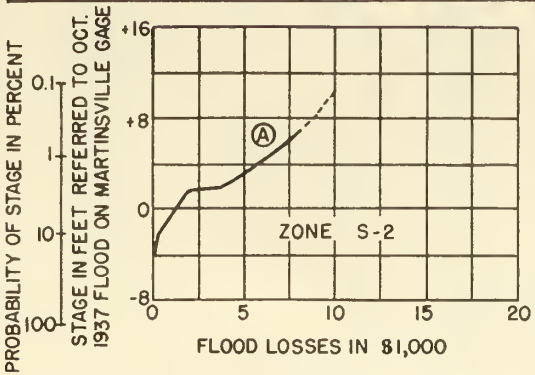


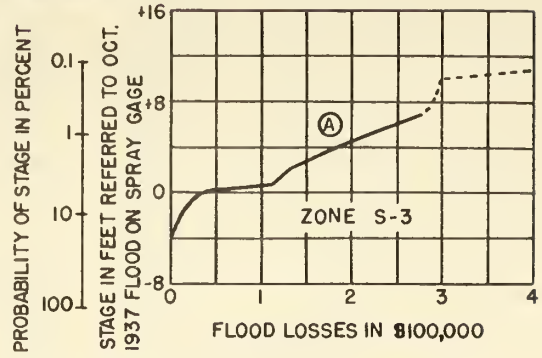
-LEGEND-
FIG. 1

- EXISTING RESERVOIRS
- RECCOMMENDED INITIAL RESERVOIRS
- RECCOMMENDED RESERVOIRS IN ULTIMATE DEVELOPMENT
- (A) DAMAGEABLE PROPERTY TO BE REMOVED BECAUSE OF INUNDATION OF FLOOD PLAIN BY RESERVOIRS

FIG. 2

- (A) STAGE-LOSS RELATIONSHIPS FOR NON-AGRICULTURAL PROPERTY





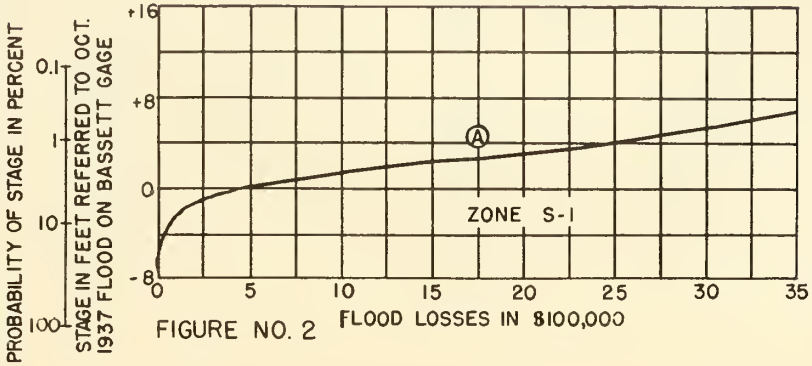


FIGURE NO. 2

FLOOD LOSSES SMITH RIVER

CHART XX

On Chart XX are shown certain typical stage-loss graphs. Of particular interest are the graphs of accumulated average annual flood losses from the mouth of the Smith River to Philpott No. 4 Dam. One graph shows the existing losses, i. e., probable average annual future losses for the unregulated stream; another shows these flood losses as they will probably be modified by the Philpott No. 4 Development; a third shows the condition of flood damages as they will be modified on the Smith River for the proposed complete development.

The foregoing data has been taken from the Review Report and the estimates of annual flood damages and annual flood benefits are on the basis of property and crop values at the time of preparation of that report. (Submitted by the District Engineer, Norfolk, Va., January 30, 1943.) No corrections have been applied for subsequent change in purchasing power of the dollar.

The Review Report estimates the annual flood damages for the Smith River below Philpott No. 4 Dam at $154,300 and the annual flood benefits accruing to the development at $150,000, which will be divided $143,000 to Virginia and $7,000 to North Carolina.

Table XXIII gives the flood damage data in the Smith River Valley for three major floods.

TABLE XXIII - ESTIMATED LOSSES FROM PAST FLOODS - SMITH RIVER
(Data from the Review Report, Corps of Engineers)

Date of Flood	Flood Damage		
	Crops	Other	Total
August, 1940	$22,000	$182,000	$204,000
October, 1937	27,000	620,000	647,000
August, 1928	18,000	63,000	81,000

Table XXIV gives the value of the property on the Smith River flood plain, exclusive of land values. It should be noted that as of the time of preparation of the Review Report, the developments on the flood plain of the Smith River from Philpott No. 4 Dam to the mouth total $12,048,000.

TABLE XXIV - VALUE OF PROPERTY ON THE FLOOD PLAIN
EXCLUSIVE OF LAND VALUE - SMITH RIVER
(Data from the Review Report, Corps of Engineers)

Type	Zone			Total	Total Roanoke River Basin
	S-1	S-2	S-3		
Industrial	$4,894,000	$1,512,000	$2,258,000	$ 8,664,000	$49,549,000
Commercial	864,000	101,000	65,000	1,030,000	2,673,000
Residential	597,000	61,000	- - -	658,000	1,651,000
Communications & Utilities	458,000	397,000	- - -	855,000	10,813,000
Public Structures	302,000	318,000	221,000	841,000	4,355,000
Total	$7,115,000	$2,389,000	$2,544,000	$12,048,000	$70,370,000*
Per Cent of Roanoke River Basin	10.1	3.4	3.6	17.1	100.0

*Includes $1,329,000 Farm Improvements.

For flood control, 3 inches of runoff from the drainage area can be retained below the spillway crest in controlled storage and 6.8 inches above the crest in uncontrolled storage. Such storage will reduce any flood of record to an inconsequential outflow. Outflows from the reservoir, if it had been in existence at the time of occurrence of four floods, together with the observed peak discharges at Bassett are given below. The estimated peak discharges at Bassett for the two largest floods of record had Philpott No. 4 Project been in operation are also shown.

Flood Data	Maximum Outflow Philpott No. 4 (computed) Cfs.	Peak Flow at Bassett, Va. (observed) Cfs.	Reduced Peak Discharge Bassett, Va. Cfs.
August, 1940	2,200	27,000	5,000
August, 1939	0	24,000	- - -
October, 1937	10	37,000	7,000
October, 1932	0	26,200	- - -

As the reservoir controls 84 per cent of the drainage area above Bassett, flows at Bassett would not differ greatly from the reservoir outflows. Because of the larger volume of the August, 1940 flood, the storage below the spillway crest that is reserved for floods would have been filled and a small flow discharged from the reservoir. This would have occurred after the flood from the uncontrolled area had passed Bassett and would not have increased the peak discharge at that point.

Due to the small area controlled by Philpott No. 4, its effect decreases rapidly as the distance from the dam increases. This is shown below by comparison of the discharges that would have occurred at Bassett and Martinsville, Va., and Spray, N. C., with those that were observed in August, 1940 and October, 1937.

Location	Drainage Area Controlled by Philpott Per Cent	Flows in Cubic Feet per Second August, 1940 Observed Peak Flow	August, 1940 Flow as Reduced by Philpott	October, 1937 Observed Peak Flow	October, 1937 Flow as Reduced by Philpott
Bassett, Va.	84	27,000	5,000	37,000	7,000
Martinsville, Va.	57	34,200	30,000	39,000	15,000
Spray, N. C.	39	38,000	31,000	35,000	26,000

The municipality in the Smith River Valley most badly damaged by the flood of 1937 was Bassett, Va., which experienced nearly half of the loss suffered by the entire valley. Philpott No. 4 Reservoir would have completely prevented this loss of $361,500. It should be noted from data presented on page 77 of this report that the no-damage stage of 17.0 at Bassett, Va. would not have been exceeded by any of the floods of record had Philpott No. 4 Project been in operation during these floods. Under that condition only the flood of August, 1940 would have exceeded the no-damage stage at Martinsville, Va., when because of the heavy rainfall on the drainage area below the dam, the reduction in stage would have been only one foot. These same data show that no-damage stage of 16.5 at Spray, N. C. would have been exceeded

by 2.8 feet in October, 1937 and 4.6 feet in August, 1940. Philpott No. 4 would have effected a reduction of 3.2 feet and 2.8 feet respectively in the stage of the floods at Spray. This further shows the effect on the flood heights at Spray of the uncontrolled drainage area below Philpott No. 4.

POWER BENEFITS - Water power does not play such an important part in the economic justification of Philpott No. 4 Project as it does for Buggs Island. The Corps of Engineers estimates that the Philpott No. 4 Project could be constructed as a flood control reservoir and could be economically justified without power generation. In its report the following statement is made:

> "However, if a multipurpose reservoir were constructed at this site, with impoundment of water for power production and low water regulation in addition to the reservation made for the primary function of flood control, it would insure that the economic potentialities, as well as all other values of the site, would be fully utilized."

In regard to a market for the water power, the report of the Corps of Engineers reads as follows:

> "After the war the potential power could be utilized to furnish firm energy and reserve requirements in local cooperative enterprise serving the municipal systems at Danville and Martinsville, and to industrial plants at Bassett, Fieldale, and other localities in the Smith River Basin. The normal growth of electrical requirements in Power Supply Area 10 is expanding at a rate which could absorb the potential power available from the project in less than one year. Consequently, as an alternative to its utilization in the proposed local cooperative after the war, this potential power could be absorbed economically in the peak-load service of the existing inter-connected utility systems now serving the area, or as replacement to one or more of the obsolete steam-generating units now performing this function."

LOW WATER REGULATION - The Review Report estimates that an annual benefit of $10,000 would result from low-water regulation if minimum flows of 32 cubic feet per second were maintained at Bassett and 75 cubic feet per second at Martinsville, Virginia. These benefits would accrue from the alleviation of stream pollution from industrial and domestic wastes now discharged into the stream, and by increase in the amount of water for industrial purposes above that normally available in the dry-flow periods. The Corps of Engineers, by reservation of storage in the Philpott No. 4 Reservoir and by proper releases from the lake, proposes to maintain the above minimum flows at Bassett and Martinsville.

ECONOMIC DATA - The Review Report gives the following data on the Philpott No. 4 Project:

INITIAL FEDERAL COSTS

Dam and Appurtenances	$3,675,000
Estimated Flowage Cost	
Reservoir Clearing, Land, and Buildings	257,000
Relocations and Adjustments	81,000
Power Tunnel and Penstocks	310,000
Power House and Equipment	347,000
Step-up Transformers and Switchyard	235,000
Total Estimated First Cost	$4,905,000
Interest during Construction	215,000
Total Estimated Federal Investment	$5,120,000

ANNUAL FEDERAL CARRYING CHARGES

Interest	$ 146,400
Amortization and Replacement	58,600
Maintenance and Operation	22,800
Federal Annual Carrying Charges	$ 227,800

ANNUAL BENEFITS

Value of Power at Site	$ 115,500
Value of Regulation to Downstream New Hydro Plants	30,200*
Value to Downstream Existing Hydro Plants	21,000
Low-Water Regulation Benefits	10,000
Flood Control Benefits	150,000
Total Annual Benefits	$ 326,700

ECONOMIC RATIO (Annual Charges to Annual Evaluated Benefits) 1 to 1.44

*Estimated value of regulated flow at the proposed Buggs Island, Gaston, and Roanoke Rapids Projects. If Buggs Island only is considered, the value is $8,000 and the economic ration 1 to 1.34.

REVISED DESIGN - The Corps of Engineers furnished six pages of "Pertinent Data", Philpott Reservoir, as a preliminary draft which was dated October 18, 1946 and which contains data on the revised design. The comparison, where applicable, of the principal details with the original design is given below:

DAM AND APPURTENANCES

	Original Design	Revised Design
Location	not changed	
Type	Rolled Earth	Concrete Gravity
Length-Dam		
Non overflow sections (Ft.)	945	800
Spillway (Ungated) (Ft.)	- - -	120

	Original Design	Revised Design
Length-Spillway (Ft.)	130	- - -
-Diversion and Outlet Tunnel (Ft.)	1,750	- - -
-Power Tunnel (Ft.)	1,050	- - -
Maximum Height (Ft.)	214	222
Maximum Width at Base		
Spillway Section only (Ft.)	- - -	163
Spillway Section Including Apron (Ft.)	- - -	403
Earth Embankment (Ft.)	1,300	- - -
Spillway Gates	ungated	ungated
Sluices		
Number	- - -	3
Size (Ft.)	- - -	6 x 7½
Capacity - Pool Elev. 985 (Cfs.)	- - -	10,000
Elevations in Terms of Mean Sea Level		
Top of Dam	1,020	1,017
Flood Plain (General Elev.)	820	815
Base of Dam (approx.) (M. S. L.)	806	795
Crest of Spillway	995	985
Maximum Flood Control Pool	1,013	998
Maximum Surcharge Elevation (Spillway Design Flood)	1,013	1,016
Maximum Power Pool	986	974
Usual Minimum Power Pool	- - -	962
Occasional Minimum Power Pool	925	920
Power Installation		
Generators - Number	2	3
Rated Capacity (2) (Kw.)	4,500	6,700
(1) (Kw.)	- - -	600
Total (Kw.)	9,000	14,000
Turbines - Type	Vertical Francis	Vertical Francis
Rated Capacity at 165 ft. head (Hp.)	6,400	- - -
at 150 ft. head (Hp.)	- - -	10,800
at 150 ft. head (Hp.)	- - -	960
Water Use (overall) (Cfs.)	759	1,560
Power Output		
Primary Capacity, gross (Kw.)	- - -	2,060
Reduction by Releases for Non-Power Purpose (Kw.)	- - -	400
Primary Capacity, net (Kw.)	- - -	1,660
Dependable Capacity at 20% C. F. (Kw.)	- - -	8,300
Average Annual Energy for Load		
Minimum Kw. - Hr.	22,400,000	18,000,000
Average Kw. - Hr.	23,600,000	24,500,000
Construction Quantities		
Concrete (Cu. Yd.)	- - -	330,000
Earth Excavation (Cu. Yd.)	- - -	21,000
Rock Excavation (Cu. Yd.)	- - -	85,000

	Original Design	Revised Design
RESERVOIR		
States Affected	Virginia	Virginia
Counties Affected		Franklin, Patrick, Henry
Length at Elev. 985 (Miles)	- - -	16
Length of Shoreline at Elev. 985 (Miles)	- - -	110
Maximum Width at Elev. 985 (Miles)	- - -	0.75
Storage (Flat pool assumption)		
Total Volume at Elevation	1,013	1,016
(Acre-Feet)	317,000	332,000
Uncontrolled Flood Storage (Elev.)	1,013 to 995	1,016 to 985
(Acre-Feet)	77,000	130,500
Controlled Flood Storage (Elev.)	995 to 986	985 to 974
(Acre-Feet)	34,000	34,100
Power Storage (Elev.)	986 to 925	974 to 920
(Acre-Feet)	140,100	111,100
Unusable Storage (Acre-Feet)	65,900	56,300
Reservoir Surface (Flat pool assumption)		
At Maximum Flood Control Pool (Elev.)	- - -	998
(Acres)	- - -	4,060
At Crest of Spillway (Elev.)	995	- - -
(Acres)	3,900	- - -
At Maximum Power Pool (Elev.)	986	974
(Acres)	3,400	2,880
At Minimum Power Pool (Elev.)	925	920
(Acres)	1,450	1,350
Original River Area (Acres)	- - -	320
Lands and Acquisitions		
Property to be Acquired (Acres)	- - -	5,031
Annual Tax Loss to Counties	- - -	$600
Population Displaced	- - -	243
Urban Areas Affected	- - -	none
Schools Affected	- - -	1
Farms in Area below Elev. 998	- - -	51
Cleared Area (Acres)		
Between Elev. 985 and Elev. 974	- - -	140
Below Elev. 974	- - -	1,280
State Park Affected (Fairystone)	1	1
Alterations and Relocations (Miles)		
Highways (Secondary)	0.75	0.50
Railroads	none	none
Transmission and Distribution Lines	- - -	0.6
Cemeteries, Approx. Number Graves	- - -	57

The Philpott Reservoir, if built according to the revised design, will reduce a natural flood flow at Bassett, Va., of about 100,000 cubic feet per second to 20,000 cubic feet per second, the no-damage discharge. A flow of 100,000 cubic feet per second at Bassett is 2.7 times the flow of record, namely 37,000 cubic feet per second. During such a flood, water would be stored

in the reservoir to an elevation of 998, which is 13 feet above the spillway crest. The discharge from the reservoir at elevation 998 is limited by the spillway dimensions to 20,000 cubic feet per second. This spillway discharge would occur after the peak flow from the intermediate drainage area had passed Bassett. The maximum storage in the reservoir would be 82,400 acre-feet, which would retard the flood waters sufficiently to eliminate all flood damage at Bassett. The Corps of Engineers also estimates that the revised design would increase the minimum weekly mean flow of record at the dam, that of 1932, from 40 cubic feet per second to 180 cubic feet per second.

No revised cost figures were included in the October 18, 1946 "Pertinent Data."

ROANOKE RIVER BASIN REPORT

SECTION V

A DISCUSSION OF THE DEVELOPMENT OF THE ROANOKE RIVER AS PROPOSED BY THE CORPS OF ENGINEERS

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A DISCUSSION OF THE DEVELOPMENT OF THE ROANOKE RIVER AS PROPOSED BY THE CORPS OF ENGINEERS

INTRODUCTION - For a hundred years or more the Federal Government has been actively interested in the rivers of Virginia but only in the past twenty years has the Corps of Engineers been authorized to study the possibility of developing such rivers for multiple benefits to citizens in general and, further, instructed by Congress to add electric power generation to the list of benefits accruing from the development of a river.

It is doubtful that citizens of Virginia living any distance from the seashore were aware of the activities of the Corps of Engineers in Virginia. Probably only a few of those dwelling on the coast ever noticed the Engineers at work on the rivers and harbors unless their own livelihood depended directly on navigation. Undoubtedly most citizens had heard of dams constructed in other areas, notably by the Reclamation Service in reclaiming the arid wastes of some of the Western States.

With the advent of the New Deal an interest in the conservation of our natural resources was renewed. Soil experts had long deplored the gradual disappearance of our tillable land and, in response to the renewed interest, programs of soil conservation and flood control were seriously undertaken. Public apathy or resistance to these programs soon dissipated and today most citizens believe in the wisdom of soil conservation. However, programs were undertaken which interfered with the status quo of private interests and which caused many citizens to "view with alarm." The situation was made more tense by the development of a political bitterness not equalled in America in recent times. A tremendous controversy raged over such Acts of Congress as the one establishing the Tennessee Valley Authority and many citizens came to believe, rightly or wrongly, that it was the policy of the Federal Government eventually to take over the power industry.

It was not until the programs for developing the rivers of Virginia became a reality in the recently authorized Buggs Island Dam that citizens of Virginia became fully aware of these activities of the Federal Government within the State. This project was but a part of a coordinated and orderly program for the development of the Roanoke River Basin, and represented the first step in a complete program.

The partial development of a river without reference to its long range possibilities, may prevent the full utilization of the water resources of the river. The Corps of Engineers has prepared a complete plan for the Roanoke River which utilizes its water resources in the most advantageous manner that the Corps could devise. This plan could be justified economically on the basis of flood control, power development, navigation, pollution abatement, low water control and other benefits. The report on the Roanoke River, although available for public distribution, was not widely read and understood by citizens of Virginia. As a result they obtained their information about the project from others who opposed or supported it largely from their own personal reasons. Hence citizens have been confronted with much mis-

information, many misconceptions and half-truths, and some downright propaganda. Public statements were made to the effect that much valuable agricultural land would be taken out of cultivation to the abject detriment of Virginia, and worse still, to the benefit of a neighboring state. Others alleged that the public was being sold a Federal invasion of the private power industry under the guise of flood control. Some claimed that no power shortage existed, or was likely to exist, in the area; others could forsee a market for all proposed power. What was the story told by the report of the Corps of Engineers? Who and what could be believed?

Some of the more important aspects of the proposed development are discussed in the following paragraphs:

FLOOD CONTROL - The total annual benefits estimated in the Review Report as accruing from the ultimate development of the Roanoke River and its tributaries are $7,692,400. Corresponding annual charges are estimated at $5,223,300. The total annual benefits are the sum of individual estimates consisting of $7,281,400 for hydroelectric power, $369,000 for flood control, $10,000 for low water regulation, and $32,000 for power benefits to several existing downstream hydroelectric plants. Generally speaking, flood control benefits in the Roanoke River Basin constitute a very small fraction of the total benefits estimated as accruing to the region from the proposed plan of development.

With the exception of Philpott No. 4, the flood control benefit accruing to each separate project of the complete plan is a small fraction of the total benefit arising from that project; in a number of instances of individual projects no specific flood control benefit is claimed nor included in the economic balance sheet for the project. The value of hydroelectric power is by far the greater part of the total benefits of each project with the single exception noted.

It is perfectly clear that the Buggs Island Project could not be built economically for flood control purposes only. In other words, the flood benefits are very small in comparison with the benefits to be derived from the sale of power, although the unevaluated benefits from flood control may outweigh the evaluated benefits. This fact, together with the arguments of those opposed to the presence of the Federal Government in the power business, has led many to object to the use of the term "flood control" in connection with the dam and to feel that semantic honesty requires that it first be called a power dam.

It is a plain and simple economic fact that benefits from flood control cannot be achieved for the Roanoke River Basin, generally, except by the use of multi-purpose reservoirs and the sale of hydroelectric power generated thereby. Advocates of flood protection in the Roanoke River Basin by other means, not involving the generation and sale of hydroelectric power, simply do not know, or choose to ignore, the basic economic factors of the problem. The generation and sale of power affords the sole means by which the benefits of flood control may be secured, generally, on the basis of self-liquidating projects.

In the case of Philpott No. 4, noted above as an exception to the general situation, the Review Report, in terms of 1940 prices, estimates the annual

benefit from flood control as $160,000, which includes an item of $10,000 for the benefits of low water regulation. If this project be constructed and used for flood control only the annual charges are estimated at $135,600, thus giving an economic ratio of 1.00 to 1.18 without power benefits. It is the only project of the comprehensive plan as presented in the Review Report, that has a satisfactory economic ratio if constructed for flood control only. If designed as a multi-purpose project and benefits from the power at the site are included, the Review Report estimates total annual charges and benefits as $227,800 and $296,500 respectively, which gives an economic ratio of 1.00 to 1.30.

The flood protection afforded by Philpott No. 4 is almost wholly confined to the Smith River Valley below Philpott and lying in Virginia. A small portion of the total flood benefits would accrue to the town of Spray, N. C., at the confluence of the Smith and Dan Rivers.

For Buggs Island the total annual charges and benefits, as exhibited in the revised estimates of "Pertinent Data", dated March 13, 1946 and based on 1942 prices, are respectively $2,295,000 and $2,658,000 from which an economic ratio of 1.00 to 1.16 results. The value of the flood control benefits is estimated as $267,000 annually. About 97 per cent of this total for flood control benefit accrues to the Roanoke River Valley in North Carolina; the remainder being in Virginia. The construction of the Buggs Island Project, as now revised, will result in almost complete elimination of flood damage on the Roanoke River below that point.

Buggs Island and Philpott No. 4 combined provide practically all the flood control features included in the complete plan. The total flood control benefits for the remainder of the ultimate plan as estimated in the Review Report amount to only $12,000 annually.

SILTING OF RESERVOIRS - Data collected by the Soil Conservation Service of the U. S. Department of Agriculture in the Southeastern Region of the United States indicate that a properly designed reservoir will have a reasonably long useful life. The average annual loss of storage due to silt in reservoirs having more than 200 acre-feet of storage per square mile of drainage area is estimated by the Soil Conservation Service as 0.31 per cent. Within the first fifty years Buggs Island storage would be reduced between 15 and 16 per cent. This would be largely in dead storage volume. The loss in flood storage would be very small and that in power storage probably about five per cent. After 100 years, when a much larger percentage of the silt will be deposited in useful storage, the rate of depletion of the useful storage will increase. The recent improvements in land use and the continued progress of such improvements will prolong the useful life of Buggs Island.

HYDROELECTRIC POWER - The Buggs Island Project will provide a considerable amount of hydroelectric energy but this energy must be sold at rates very nearly equal to present steam generation costs if the project is to be self-liquidating. The energy so provided will occupy a good competitive position with respect to steam generated power but it will not be cheap power in the common acceptance of the term.

In 1943, the steam generated energy was 80 per cent of the total generation of the Appalachian Electric Power Company and 91 per cent of that of the

Virginia Electric and Power Company. Hydroelectric power is independent of coal shortages due to labor difficulties at the mines or on the railroads. Hydroelectric plants are also less vulnerable to labor difficulties because of the small number of operating and maintenance personnel. Buggs Island occupies an excellent strategic position with respect to a number of power load centers in Virginia and North Carolina. The value assigned the power from this site, as it appears in the study exhibiting economic justification of the project, seems to indicate clearly that this plant must be integrated for the most part with the public utility systems serving Power Supply Areas 18 and 21. In arriving at the economic ratio of 1.00 to 1.16 the output from Buggs Island has been set up in the economic study on the basis of a 23 per cent capacity factor for the plant. (Based on a dependable capacity of 90,000 kilowatts) To achieve this schedule of operation Buggs Island evidently must be integrated with the present utility system for the purpose of carrying peak loads. If so integrated, it would not only furnish additional needed energy but also provide a better balance between hydro and steam power. If the project is to be self-liquidating, the energy provided by Buggs Island for the purpose of carrying base loads for local utilities and rural electrification services, must be sold at a rate not less than that estimated for energy delivered at a 23 per cent capacity factor.

This lack of flexibility in the Buggs Island development will be corrected to a considerable degree when the lower power sites at Gaston and Roanoke Rapids, N. C., are developed and operated in conjunction with Buggs Island to form a better balanced hydroelectric generating system.

The economic ratio of 1.00 to 1.16 for Buggs Island as authorized implies that this project is little better than a break-even proposition when standing alone. However, when the developments at Gaston and Roanoke Rapids are added the advantages of the large storage at Buggs Island will be more completely realized. The three plants operated as an integrated system will yield a considerably higher economic ratio. Thus Buggs Island is the primary and key installation of these three down river plants so far as power generation is concerned. At the same time, it provides almost complete flood protection for the lower Roanoke River basin.

The Philpott Project, in its preliminary analysis and with its costs based on 1940 prices, has an economic ratio of 1.00 to 1.44, when benefits to the Buggs Island, Gaston and Roanoke Rapids Projects are included. If benefits to a new downstream hydro-plants are limited to Buggs Island only, as estimated in the report, this economic ratio is 1 to 1.34. Its energy could probably be consumed in public power distributing agencies or the principal utility system serving Power Supply Area 10.

The other projects, which are discussed below, are included in the adopted program but are not authorized. Data on these projects were taken from the Review Report and will be subject to revision as final plans are prepared. It is doubtful if these projects will be constructed in the immediate future. In a manner similar to Buggs Island, the Smith Mountain Development on the upper Roanoke River provides considerable storage which is subsequently utilized as regulated flow at the intermediate developments at Leesville, Taber, Melrose, and Randolph as well as at the three down river plants. Because of the small tributary area at Smith Mountain, storage at that point is of lesser importance to the intermediate developments than storage at Buggs Island is to

the developments at Gaston and Roanoke Rapids. With the exception of an annual flood benefit of $10,000 assigned to Smith Mountain no benefits are claimed for any of these up river plants except for power generation. In effect the five developments as listed above are substantially power projects and power projects only. The economic ratio for these five up river plants, considered individually, or as an integrated system, does not appear impressive. The remaining two projects, at Stuart on the Smith River and at Schoolfield on the Dan River, yield poor economic ratios. Benefits from these two projects are confined solely to the generation of hydroelectric energy except that an annual flood control benefit of $2,000 is assigned to the project at Stuart.

From information available in the Review Report and from power market studies of the Federal Power Commission, the Roanoke River Region and contiguous areas seem capable of providing a market in the foreseeable future for all the hydroelectric energy which may be generated at Buggs Island, Philpott No. 4, Gaston, and Roanoke Rapids. This energy can be marketed in such quantities and at such rates as to liquidate these projects within their estimated life. Such an estimate is predicated upon the hypothesis that the bulk of this power will be marketed through the present utility systems while at the same time lesser amounts may be made available to rural electrification service and minor utilities.

The presence of the Federal Government in the power business is a matter of policy which is determined at higher levels than our committee. There are those that foresee only harm in this policy; others feel that the Federal Government should be in the business of generating power just as it is in the business of carrying the mails. The fact is that the Federal Government has authority to generate power as part of its operation of multipurpose dams and that it proposes to do so in Virginia.

There is a need, however, for a clearer statement of the objectives and policies of the Federal Government in the power business. Much suspicion could be allayed if a policy were established in the matter of sale of power in a specific case such as this. It is assumed that the existing power networks will handle the power from Buggs Island since the higher priority distributors are practically non-existent in the area. It would seem better if the private power companies could find out before the Buggs Island power is ready for distribution just where they fit into the picture. It would, of course, be desirable to know whether the government will someday go into distribution in competition with existing transmission facilities.

Another point worthy of emphasis is that the whole Power Supply Area 18 is out of balance as regards the integration of steam and hydro plants. From the standpoint of power generation theory it would seem that an area served by steam plants to an extent of more than 90 per cent of total power should be ripe for some hydro development, expecially where the possibilities for such development are as abundant as in Virginia. As a matter of fact, the percentage of hydro development of the principal utility serving Power Supply Area 10 is twice as great as the percentage of hydro development of the principal utility serving Power Supply Area 18. When consideration is given to the fact that Power Supply Area 10 is located closer to the coal fields than is Power Supply Area 18, even when making due allowance for any probable greater transmission costs in the former, it seems evident

that Power Supply Area 18 is underdeveloped from the standpoint of hydro generation. When it is further noted that Claytor Dam was built in Power Supply Area 10 in recent years with an installed capacity of almost twice the capacity of the whole hydro system of the principal utility serving Power Supply Area 18, it must be presumed that the Buggs Island Project could readily be fitted into an integrated power system in the latter power area.

LOW WATER REGULATION AND POLLUTION ABATEMENT - The major benefit from low water regulation will be realized in the narrow and highly industrialized Smith River Valley from Bassett to Martinsville, Virginia. The quality of this water is well suited to industrial uses. If minimum flows in the Smith River are maintained sufficiently high to alleviate pollution from domestic and industrial wastes and to provide sufficient water for industrial uses considerable benefits will accrue. The Philpott No. 4 Project is estimated to provide minimum average weekly flows of 185 and 200 cubic feet per second at Bassett and Martinsville respectively for a critically dry period such as 1930-32. The annual benefit from such low water regulation was estimated at $10,000 in the Review Report. Larger minimum flows during less critically dry periods would correspondingly be available.

In the remaining portions of the Roanoke River and its tributaries affected by the proposed ultimate plan of development, there are no other points at which low water regulation and pollution abatement constitute a serious problem under the existing development of the region. Therefore in no other instance, except the above, are specific benefits from low water regulation estimated and credited to the project. However, as projects of the ultimate plan are successively authorized and constructed there will ensue a degree of stream regulation which will provide larger minimum flows of improved quality. While at present intangible, such benefits may be realized in the future by promoting a desirable degree of industrial development within the region.

The increased flows resulting from proper operation of the dams will certainly enable the rivers better to handle the pollution. In conjunction with the new Water Control Act of Virginia this may be one of the first positive steps towards the abatement of pollution.

IMPROVEMENTS TO NAVIGATION - No benefits from improvements to navigation have been assigned to the ultimate development in determining its economic justification. Certain potential benefits exist but are confined to that part of the Roanoke River lying in North Carolina. At present Palmyra is the head of navigation on the Roanoke River and a channel depth of 8 feet or greater exists from that point to the mouth of the river. The project at Buggs Island would permit the extension of an 8 foot channel from Palmyra to Weldon, a distance of 50 miles, by means of a dam and lock at river mile 114 and the use of the minimum flows from upstream storage. Under present conditions the proposed upstream developments do not impair navigation below Palmyra. It is doubtful that future conditions will warrant the extension of navigation from Palmyra to Weldon.

GENERAL EFFECTS OF THE PROPOSED DEVELOPMENTS, BENEFICIAL OR OTHERWISE - From the ultimate development, or any of its intermediate stages, there will follow certain incidental and intangible effects which are not susceptible to evaluation in direct monetary terms. These effects may,

or may not, be beneficial, either individually or collectively. Some of the principal effects following partial or complete inauguration of the proposed ultimate plan are listed below. The discussion of these effects will be limited to the presently authorized projects at Buggs Island and Philpott No. 4.

1. Interruption of lines of communication in the areas covered by the reservoirs.

2. Isolation of certain areas from their present neighboring communities.

3. Permanent flooding of certain fertile areas principally in the narrow river valleys in close proximity to the streams.

4. Reclamation of considerable wooded areas and marginal lands which may be later used for agricultural purposes.

5. Improvement of the quality of the stream for municipal and industrial uses by removal of silt.

6. Loss in taxes to the counties from land acquired by the U. S. Government for reservoir backwater or for other purposes.

7. Availability of the reservoirs and adjacent areas for public recreational use and the unevaluated benefits to fish and wildlife.

8. Reduction of damage to normal or accelerated future property developments and a corresponding reduction in the probability of loss of life during future floods.

9. Improvement in the quality and quantity of stream flow and the encouragement thereby given to future industrial development in the region.

The Buggs Island Reservoir will sever or disrupt a number of lines of communication - principally highways, to a lesser extent public service lines such as telephones or rural power lines, and to a still smaller extent railroad lines. The highways of principal importance in the area will be relocated with little impairment in service to the general public. Some secondary and neighborhood roads must be relocated and rebuilt and some new roads must be provided. On the other hand a number of neighborhood and secondary roads must be abandoned completely. Some public service lines must be abandoned but in such cases they will be relocated to maintain service to the patrons tributary thereto. Some railroad relocation will be required in the area but no substantial changes will be required nor will the normal service be impaired.

In the case of Philpott No. 4 no principal highways cross the reservoir area. A few secondary highways must be relocated or abandoned. The relocation or abandonment of public service lines constitute a minor item. There are no railroads lying within the reservoir area.

The very considerable body of water resulting from the Buggs Island Dam will produce backwater ramifications in Virginia and North Carolina to such a degree that a number of areas will be isolated from their neighboring communities. Areas completely cut off will be acquired by the government. Most areas not cut off completely will be served by relocated lines of communication, and/or new lines of communication, with substantially the same convenience as heretofore. A few areas, principally bordering on North Carolina, will be completely cut off from neighboring Virginia communities and must use new, and perhaps less convenient, lines of communication giving egress through North Carolina. However, on the whole the proportion of the population isolated by the backwater ramifications seems not to be large nor the inconvenience produced serious or substantial.

The Philpott No. 4 Reservoir lies in a sparsely inhabited area, is relatively small, and will be confined to valleys which for the most part are quite narrow. Inconveniences due to isolation will constitute an item of minor importance.

In Virginia, the Buggs Island Project will permanently flood 33,800 acres, and will occasionally flood a further area of 29,340 acres. The counties affected are Mecklenburg, Halifax and Charlotte in decreasing order of magnitude. In the above totals such areas as lie in the river bottom of the Roanoke River and its tributaries may consist of very fertile agricultural land. However, the proportion of such fertile areas to the total acreage permanently or infrequently flooded is small. As the level of the reservoir rises above the flat but narrow stream valleys the fertility of the additional areas flooded becomes considerably less. A large proportion of the area to be acquired for the Buggs Island Reservoir consists of marginal farm land or land covered with second growth forests. The Corps of Engineers, in a letter dated July 16, 1946, estimated the total cost of real estate in the reservoir area as $4,445,320. The River Basin Committee estimates this to be located approximately $3,209,000 in Virginia and $1,236,000 in North Carolina. The Corps of Engineers in the preparation of the Review Report, estimated the total value of property, for the most part located in North Carolina, which is protected against flood damage by the Buggs Island Reservoir to amount to $19,037,000. This does not include land or crop values. The Federal Government proposes to acquire such areas as may be needed by an orderly procedure in which the property rights of those affected will be protected and a fair price paid for all lands acquired. A total of 325 rural and 55 urban families must be removed from the reservoir area. Of this total, 156 rural and all of the urban families are located in Virginia.

There is every reason to believe that those displaced in the region may have three or more years work on the project at good pay. During this time they will have an opportunity to go into the matter of relocation intelligently. With a good income for the time being they can purchase better land than that on which they formerly lived. Being driven from the marginal farm can hardly fail to better their conditions in this case. Those who are not displaced may find their way of life somewhat altered as a result of changes in transportation routes. Some will find their trade routes sufficiently altered that they will have to develop a new community life. It is doubtful that this will be serious for two reasons: first, the numbers involved are small in comparison with the economic importance of the project; second, human beings adapt themselves in a few months to new routines. As a matter of fact, the disrup-

tion of the way of life of an individual is not the unmitigated crime that many would have us believe, as long as that upset does not involve a descent from plenty to poverty.

It is estimated that the purchase of land for the Buggs Island Reservoir will reduce the annual tax revenue in Mecklenburg County by $12,508, in Halifax County by $4,629, and in Charlotte County by $829; making a total reduction for Virginia of $17,966. The present policy of the Federal Government gives no guarantee of any substantial direct replacement of this loss in tax revenue. Indirect benefits from increased travel to the area, stimulated business and industrial development, improvement in rural electrification systems, or in lieu tax payments from the government could reduce or eliminate the effect of this tax loss.

The Philpott No. 4 Project will result in an annual tax loss of $567 distributed among the counties of Franklin, Henry and Patrick.

It is doubtful that the Buggs Island Reservoir and adjacent areas will be generally satisfactory for recreational purposes. Large areas of the Piedmont Region are covered with soils in which clay predominates. During and following floods, streams draining this area carry in suspension considerable amounts of clay of such small particle size as to require long periods of quiescence in reservoirs to produce a satisfactory degree of clarification. On account of this it is at least open to question whether the prevailing clarity of the water in the Buggs Island Reservoir will be such as to make the lake attractive for recreational purposes. There is little information of good comparative value available and such information as exists hardly warrants any definite conclusion in the matter. The schedule of operation at the Buggs Island Dam will necessitate continuous and wide fluctuations in the level of the reservoir. Although the daily fluctuation will be small, this will result in the exposure, or flooding, of muddy shore lines in widths of varying amounts. This presents a condition which is not favorable to the use of the lake for recreational purposes. However, if the quality of the water is prevailingly satisfactory it may be possible to construct artificial beaches and other appurtenances at suitably selected points and in such manner as to make considerable use of the reservoir lake for public recreational purposes.

The potential value of the Philpott No. 4 Reservoir for public recreational purposes should be relatively greater than that of Buggs Island. This reservoir is located at a much higher altitude where the average summer temperatures are lower and generally more pleasant. The shore lines of this reservoir will be generally steeper than those at Buggs Island. A greater proportion of the watershed area is forested and it seems reasonable to suppose that the prevailing quality of the water in the reservoir will be better. Finally, this reservoir is very close to a State recreational area at Fairystone Park and possibilities exist for the integration of both of these developments to their mutual advantage.

The Buggs Island Development gives almost complete flood protection to the Roanoke River Valley below that point. Future flood protection benefits have been based on past flood damage records and in turn these flood damages have arisen from developments on the flood plain restricted and conditioned by the ever present threat of future floods. Such conditions necessarily impose a certain degree of restraint on normal development within the area. The

assurance of future flood protection will probably result in acclerated developments on the flood plain which heretofore, under the constant threat of flood damage, have seemed impractical or unwise. Thus additional flood protection benefits may arise from the normal, or more particularly the accelerated, rate of development for the protected area.

The highly industrialized area situated in the narrow valley of the Smith River between Bassett and Martinsville is similarly almost completely protected against flood damage by the Philpott No. 4 Project. Correspondingly, unestimated flood protection benefits will accrue from the normal and/or accelerated rate of development when flood protection is assured.

Improvements in the quality and quantity of stream flows naturally follow as the projects of the ultimate plan are successively authorized and constructed. In the case of many industries the availability of sufficient water of a satisfactory quality is an important consideration affecting plant location. Thus unevaluated potential benefits will be created as the stage development of the ultimate plan progresses, and future industrial development within the region may permit the actual realization of these potential benefits.

It is of considerable interest that the people living in the Roanoke River Basin are for the most part in favor of the project. Those in the lower reaches in North Carolina are highly enthusiastic. The benefits to farmers in Virginia are negligible as far as agricultural pursuits are concerned. It seems likely, however, that the industrialization of Virginia on a sound basis will draw labor from marginal farms and improve the standards of living of the individuals concerned. With this goes a greater good to the whole state. From a long-time point of view it seems likely that the Buggs Island Project will bring about industrialization of the area to a beneficial degree.

ADDENDA

BUGGS ISLAND AND PHILPOTT NO. 4 PROJECTS

The data for this report were largely taken from the Corps of Engineers' Review Report on the Roanoke River. This was submitted to Congress by the Secretary of War on May 30, 1944 and published as House Document No. 650, 78th Congress, Second Session. Use has also been made of the unpublished Appendices Volume I and Volume II, and unpublished plates which were prepared in the Norfolk Engineer District Office in its study on the Roanoke River. During the preparation of its report, the River Basin Committee has on several occassions requested information from the District Engineer, Norfolk Engineer District. Such information has been furnished in letter form.

The Norfolk Engineer Office has furnished copies of a compilation of data which were entitled "Buggs Island Reservoir, Pertinent Data" and dated March 13, 1946. These data gave the physical details of the project as revised by design changes since the preliminary design was submitted in House Document No. 650. The principal features of the design changes were as follows:

1. The lowering of the elevation of the maximum power pool by twelve feet and the raising of the elevation of the maximum flood control pool by three feet. This provided for the storage of a minimum of three inches of runoff from the drainage area above the dam. By tripling the flood storage that would be available at the beginning of all floods, the protection from floods for the Roanoke River Valley below the dam was increased and the Corps of Engineers increased their valuation of the annual flood benefits in accordance. They also increased these benefits by including the damage of the 1944 and 1945 floods in their computation of annual damages.

2. The lowering of the elevation of the minimum power pool by 15.6 feet. This partially compensated for the loss in power storage caused by lowering the maximum power pool by twelve feet. This cannot compensate for all of the energy sacrificed as it does not furnish the same amount of storage and the average head available is decreased.

3. Providing additional spillway capacity by increasing the number of gates and including ten sluices in the dam.

4. Providing additional generating capacity which increases the dependable capacity and allows the plant to operate at a lower capacity factor. Provisions were also made for future generating capacity. These result in a higher value for the power.

The lowering of the maximum power pool moved the slack water limits down river from South Boston and, under normal conditions, the reservoir will have no effect on that town.

The copy of "Pertinent Data", dated March 13, 1946, included a new economic summary for the Buggs Island Project. The cost estimate was based on revised designs and more complete plans. Items for which an insufficient allowance had been made were increased to properly reflect their cost. These revisions were based on unit costs of labor, material, and equip-

ment as of late 1942. The estimate included in House Document 650 also was based on prices as of late 1942.

The increase in Federal Investment from $32,300,000 as set forth in Volume I of the Appendices of the Review Report to $47,970,000 does not reflect any increase in unit cost but only the inclusion of the cost of design changes. This new cost estimate was also based on more detailed plans for the project. The increase in cost amounted to 48.5 per cent.

As these revised figures are included in the text of this report, they will not be repeated here.

The Corps of Engineers furnished, in addition, a revised edition of "Buggs Island Reservoir, Pertinent Data", dated January 28, 1947. This revision contained major changes in the estimate of cost and the evaluation of average annual benefits, although the design was the same as that presented in the data dated March 13, 1946. The changes in the estimates of costs and benefits reflected price levels as of May, 1946. This material was received too late to be included in the report. As the data to support the average annual benefits have not been made available to this committee for publication, the summary only is repeated below. No revision of the report is attempted.

ESTIMATED COSTS TO MAY 1946 PRICE LEVEL

(Buggs Island Reservoir, Pertinent Data, latest revision dated January 28, 1947 and Definite Project Report on Buggs Island Reservoir.)

Construction Quarters, Diversion, and Access Roads	$ 2,467,000	
Clearing of Reservoir	4,435,000	
Dam:		
Spillway	6,517,000	
Nonoverflow Sections	1,474,000	
Earth Wing Dikes	1,436,000	
Power Intake Section	2,858,000	
Hydroelectric Power Plant	9,581,000	
Relocations	11,747,000	
Operator's Quarters and Misc. Improvements	565,000	
Direct Cost		$41,080,000
Contingencies	$ 6,161,000	
Preparation of Definite Project Report	320,000	
Preparation of Plans and Specifications	1,030,000	
Supervision and Inspection of Construction	1,643,000	9,154,000
Subtotal		$50,234,000
Lands and Acquisitions	$ 4,897,000	
Contingencies	490,000	
Administrative Cost	661,000	6,048,000
Subtotal		$56,282,000
District and Division Overhead		1,448,000
Total Estimated Cost		$57,730,000
Interest During Construction		2,600,000
Total Estimated Investment		$60,330,000

The total estimated investment represents an increase of 87 per cent over that given in House Document No. 650.

EFFECT OF RESERVOIR

Damage Elimated Below Buggs Island From Recurrence Of August 1940 Flood	$ 4,882,000
Rural Ares Inundated by August 1940 Flood Stage and On Which Flood Damages Will be Negligible:	
Cultivated	49,000 Ac.
Total	227,500 Ac.
Urban Areas Protected From Floods:	Roanoke Rapids, Weldon, Williamston, Janesville, and Plymouth, N. C.
Value of Property Protected from Floods:	
Industrial, Commercial, and Residential	$18,357,000
Communications, Utilities, and Public Structures	6,041,000
Land and Farm Improvements	8,872,000
Total	$33,270,000

The values given for "Damage Eliminated below Buggs Island from Recurrence of August, 1940 Flood" and "Value of Property Protected from Floods" are based on the same indices as the cost estimate of the project.

AVERAGE ANNUAL BENEFITS

Average Annual Flood-Control Benefits		$ 426,000
Average Annual Power Benefits:		
At Site	$2,830,000	
To Existing Downstream Hydro Plant	30,000	
Total Average Annual Power Benefits		2,860,000
Rentals from Cleared Land and Timber Sales Above Maximum Power Pool		41,000
Total Average Annual Benefits		$ 3,327,000

AVERAGE ANNUAL CHARGES $ 2,863,000

ECONOMIC RATIO (Annual Charges To Annual Benefits) 1 to 1.16

The value of "Average Annual Flood-Control Benefits" is based on current value of property and not on its average value during the life of the project. The value of "Average Annual Power Benefits" is based on the value given in a letter dated July 19, 1946 from the Federal Power Commission to the District Engineer, U. S. Engineer Office, Norfolk, Virginia, and not on its average value during the life of the project. The basis of these estimates of the value of power was given in a letter dated October 4, 1946 from the Regional Office of the Federal Power Commission, Atlanta, Georgia, and addressed to the Virginia State Planning Board. This letter in part is as follows:

> "In preparing the revised estimate the value of Buggs Island output was computed on the basis of the cost of equivalent amounts of capacity and energy from a modern fuel-electric plant connected with the present power systems in its area. Due consideration was given to differences in system reserves, transmission losses,

and transmission costs. A capital cost of $109.00 per kilowatt, including step-up substation facilities, was used as representative of a modern fuel-electric station in the area. Fuel for the plant was estimated to cost about 25 cents per million Btu. The revised estimate of the value of power at the site of the Buggs Island Project, based on present-day costs, is $17.20 per kilowatt-year for capacity and 3.12 mills per kilowatt-hour for energy."

Data concerning the cost, average annual benefits and charges for the revised design of Philpott No. 4 Project are not available for publication. The estimates of cost given in this report are for the original design and are based on 1940 indices.

DEFINITIONS

1. Acre-foot - The amount of water required to cover an acre of land to a depth of 1 foot; equals 43,560 cubic feet.

2. Apron - The downstream portion of the spillway designed to prevent erosion of the stream bed.

3. Capacity - The load that may be safely carried continously by a power plant under specified conditions without exceeding any one of its physical limitations.

4. Capacity Factor - The ratio of the average load on a machine or equipment for the period of time considered, to the rating of the machine or equipment.

5. Dependable Capacity - That capacity which can be delivered under the worst conditions of record at a given capacity factor.

6. Drawdown - The vertical distance through which it is planned to lower the water surface from an established elevation. This established elevation is usually the level of the maximum power pool.

7. Economic Ratio - The ratio of the estimated annual charges to the estimated annual benefits as evaluated in dollars.

8. Elevations - All elevations refer to vertical distances above established mean sea level.

9. Flat Pool Assumption - The assumption that the water surface elevation is the same at all points in the reservoir. (Substantially true except during flood periods.)

10. Gates - The movable portion of a dam, sluiceway, other water channels or conduits, by which the amount of flow is controlled.

11. Gravity Section Dam - A dam which depends solely on its own weight for stability against water pressure.

12. Inches of Runoff - That portion of the rainfall (or snowfall) which in a unit of time finds its way into the stream channel and is expressed in inches of depth over the area on which it falls.

13. Kilowatts - Unit of measure of electrical power; equals 737.5 foot-pounds per second, or 1.341 horsepower, or 0.9475 British Thermal Units per second. It is the measure of the work done in one second when 10 amperes flows in a circuit under pressure of 100 volts.

14. Kilowatt-Hour - Unit of measure of electrical energy. It is the work done by one kilowatt in one hour.

15. Load - The power delivered or received at a given point at any instant.

16. Load Factor - The ratio of the average load over a designated period to the peak load occurring in that period.

17. Peak Load - The maximum load during a stated period of time. It may be the maximum instantaneous load or the maximum average load over a designated interval of time.

18. Power Pool - The extent of the reservoir surface at any level between maximum and minimum limits of power storage.

19. Power, Primary or Firm - The power intended to be always available even under emergency conditions.

20. Power, Secondary - The power that can be delivered in excess of the primary power. It is not available under all conditions.

21. Primary Capacity - That capacity which is available continously under the worst conditions in the period of stream flow records.

22. Reserve Equipment - The installed equipment in excess of that required to carry peak load.

23. Self-liquidating Project - A project in which the annual benefits equal or exceed the annual charges.

24. Spillway - The portion of a dam (or other structure) designed to discharge water over its crest.

25. Storage, Controlled Flood - The storage volume reserved for flood control in the reservoir which is below the top of spillway gates when the gates are closed (or below the fixed crest if the spillway is ungated). This water can be discharged at varying rates by operation of the gates (or sluiceways).

26. Storage, Dead - The storage volume in the reservoir below the established minimum level of the water surface. It is not planned to release this water which is used only to create head for power generation.

27. Storage, Power - The storage volume reserved in the reservoir for power generation.

28. Storage, Uncontrolled Flood - The storage volume in the reservoir above the top of spillway gates when the gates are in the closed position (or above the fixed crest if the spillway is ungated). Also called surcharge.

29. Storage, Unusable - See "Dead Storage."

30. Storm, Cold Front - A storm in which the low pressure center moves along the wedge-like face of the mass of cold air of polar continental origin.

31. Storm, Warm Front - A storm that usually occurs in the fall of the year when the land is colder than the moist air over the Atlantic Ocean.

ROANOKE RIVER BASIN REPORT

SOURCES CONSULTED

Constitution of the United States.
Decision of the U. S. Supreme Court in the New River Case (F. P. C. against Applachian Electric Power Company).
Decision of the Supreme Court in the Ashwander Case against TVA.
Decision of the Supreme Court in the Suit of the 19 Power Companies against TVA.
House Document No. 308, 69th Congress, first session.
Rivers and Harbors Act, approved January 21, 1927.
House Document No. 65, 74th Congress, first session.
Public Act 534 of the 78th Congress.
Review Report on the Roanoke River, dated January 30, 1943, of the U. S. Corps of Engineers. (published as House Document No. 650, 78th Congress, second session.)
Appendix I and II of the Review Report. (unpublished.)
Plates 6 to 62 accompanying the Review Report. (unpublished.)
Report of Virginia State Planning Board, Vol. II, Natural Resources, dated December 31, 1935.
Volume IV A, Land Use and Agriculture, dated May 1, 1937.
Volume III B, Industries, dated March 31, 1936.
Volume X, Drainage Basin Studies, dated March 1, 1937.
14th Census of the United States.
15th Census of the United States.
16th Census of the United States.
County Basic Data, Farm Journal, Inc., Market Research Dept., Philadelphia, Pa.
Data compiled by the Virginia Department of Labor and Industry.
Virginia State Commission of Conservation and Development, Bulletin No. 3.
Joint Survey of Stream Pollution in Virginia by the State Planning Board, State Commission of Game and Inland Fisheries, and the State Health Department. (unpublished.)
Technical Bulletin No. 524, Revised August, 1934, of the United States Department of Agriculture. (Silting of Reservoirs)
Miscellaneous Publication No. 521, dated 1943, of the United States Department of Agriculture. (The Control of Reservoir Silting)
Recreational Resources of the Buggs Island Reservoir, United States Department of the Interior. National Park Service.
Fish and Wildlife in the Roanoke River Basin in relation to the Proposed Buggs Island Reservoir; United States Department of the Interior, Fish and Wildlife Service.
Recreational Resources of the Philpott Reservoir, United States Department of the Interior, National Park Service.
Preliminary Malaria Survey Report of Buggs Island Reservoir on the Roanoke River in North Carolina and Virginia. Joint report of the North Carolina Board of Health, the Virginia State Health Department and the U. S. Public Health Service.

Storm Damages in the South Atlantic States, August 5-17, 1940, prepared in the office of Division Engineer, South Atlantic Division Atlanta, Georgia, with Appendices A through H.
Buggs Island Reservoir, Pertinent Data, dated March 13, 1946 of the Corps of Engineers.
Memorandum of the Tennessee Valley Authority containing Tax Data and Tax Equivalent Data. (unpublished.)
House Document No. 216, 78th Congress, first session.
The Tennessee Valley Act and the 1940 Amendment.
Memorandum Report on Power Market Study, Rappahannock River Development, Federal Power Commission as contained in Vol. III.
Review Report for Flood Control, Rappahannock River and Tributaries, dated July 31, 1944, United States Engineer Office, Washington, D. C. (unpublished.)
Staff Report on Potomac River Basin Power Market Survey, Federal Power Commission as contained in Appendix E, Potomac River Survey Report, dated April 30, 1944, United States Engineer Office, Washington, D. C. (unpublished.)
Staff Report on James River Basin Power Market Survey, Federal Power Commission as contained in Appendix E, Survey Report on James River, dated September 1, 1945, United States Engineer Office, Norfolk, Virginia. (unpublished.)
Report on the Conservation and Utilization of Water Resources in the State of Georgia.
The Commonwealth, published by the Virginia State Chamber of Commerce - particulae issues, dated April, 1946 and July, 1946.
Rural Electrification News - published by the Rural Electrification Administration, U. S. Department of Agriculture.
Proposed Federal Hydro Electric Project at Buggs Island, prepared - by Slaughter, Saville and Blackburn, Engineers, Richmond, Virginia.
Report on the Roanoke River Development, proposed by the Federal Government Slaughter, Saville and Blackburn, Inc., Richmond, Virginia.
Letters from the Corps of Engineers, Norfolk Engineer Office, Norfolk, Virginia. (not enumerated.)
Unpublished Data in the files of the Corps of Engineers, Norfolk Engineer Office, Norfolk, Virginia. (not enumerated.)
The Corps of Engineers, Norfolk Office, has been very cooperative in furnishing all data available in its files which were requested by this committee.

VIRGINIA STATE PLANNING BOARD

RIVER BASIN COMMITTEE

PRINCIPAL RIVER BASINS

AND

ELECTRIC TRANSMISSION LINES

SEPTEMBER 1946